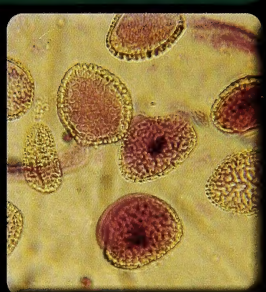



SCIENCE 14

MODULE 1 • INVESTIGATING PROPERTIES OF MATTER



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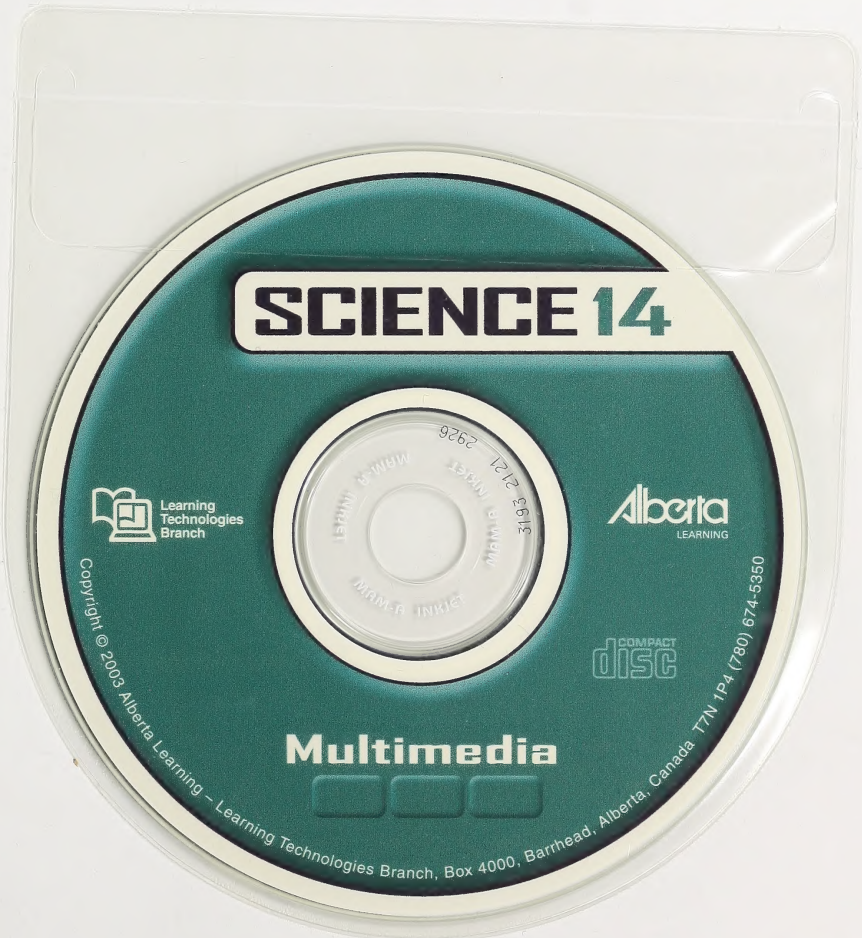
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SCIENCE 14

MODULE 1 ■ INVESTIGATING PROPERTIES OF MATTER

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Science 14
Module 1: Investigating Properties of Matter
Student Module Booklet
Learning Technologies Branch
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The Learning Technologies Branch acknowledges with appreciation the Alberta Distance Learning Centre and Pembina Hills Regional Division No. 7 for their review of this Student Module Booklet.

This document is intended for	
Students	✓
Teachers	✓
Administrators	
Home Instructors	
General Public	
Other	

You may find the following Internet sites useful:

- Alberta Learning, **http://www.learning.gov.ab.ca**
- Learning Technologies Branch, **http://www.learning.gov.ab.ca/ltb**
- Learning Resources Centre, **http://www.lrc.learning.gov.ab.ca**

The use of the Internet is optional. Exploring the electronic information superhighway can be educational and entertaining. However, be aware that these computer networks are not censored. Students may unintentionally or purposely find articles on the Internet that may be offensive or inappropriate. As well, the sources of information are not always cited and the content may not be accurate. Therefore, students may wish to confirm facts with a second source.

Welcome to

SCIENCE 14

Science 14 contains four modules.
You should work through the modules in order (from 1 to 4) because concepts and skills introduced in one module will be reinforced, extended, and applied in later modules.

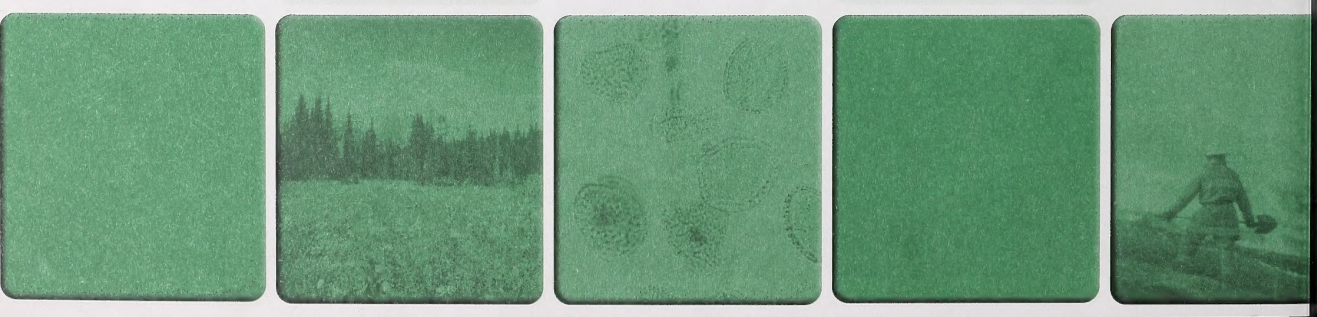
MODULE 1
■ INVESTIGATING PROPERTIES OF MATTER ■

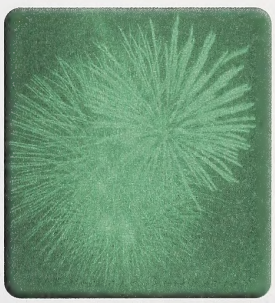
MODULE 2
■ ENERGY TRANSFER TECHNOLOGIES ■

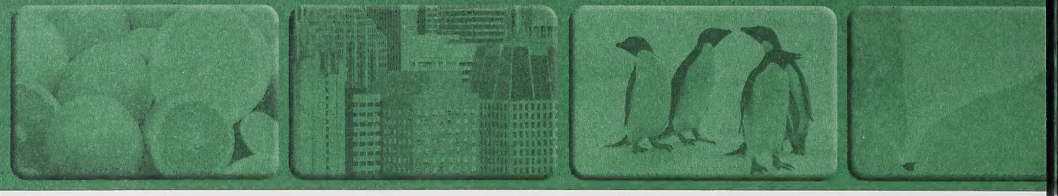
MODULE 3
■ FROM LIFE TO LIFESTYLE ■

MODULE 4
■ MATTER AND ENERGY IN THE BIOSPHERE ■

Contents



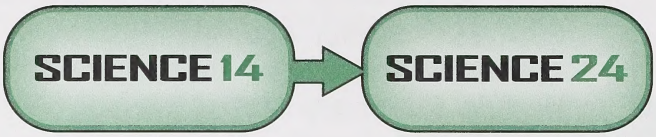




Course Features

The Science 14–24 Program

Science 14 is the first course in the Science 14–24 sequence of courses. If you successfully complete each of these five-credit courses, you will meet the minimum requirement in science for an Alberta high school diploma.



The Science 14–24 sequence is designed for students whose needs, interests, and abilities focus on basic science understanding. This course sequence emphasizes scientific and related technological knowledge and skills that will enable you to understand and interpret the world around you.

Consult your teacher or counsellor for the latest information on Science 14. Also, if you have access to the Internet, you can find out more about Science 14 and high school requirements at the Alberta Learning website.

http://www.learning.gov.ab.ca

This Science 14 course consists of four modules. Each module consists of one Student Module Booklet and two Assignment Booklets. The booklet you are presently reading is called a Student Module Booklet. It will show you, step by step, how to advance through each module.

Resources You Will Need

Textbook

To complete the course, you will need the textbook *Science.Connect 1*.

Multimedia

Attached to the inside cover of the textbook and to Module 1 of this course are multimedia CDs. These CDs contain multimedia segments designed to help you better understand particular concepts presented in this course. Ask your teacher, friend, or family member if you need help using these CDs.

Looseleaf Binder or Notebook

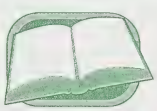
Because response lines are not provided in the Student Module Booklets, you will need a looseleaf binder or notebook to respond to questions and complete charts. It's important to keep your lined paper handy as you work through the material and to keep your responses together in a binder for review purposes later.

Materials and Apparatus

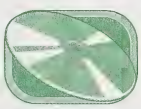
The modules include numerous science activities and investigations that require materials and apparatus. A lab kit is not needed to complete this Science 14 course. Many of the activities and investigations are set up so you can complete them using common household materials. Some investigations, however, do require lab material and apparatus. These investigations are set up with a Part A and a Part B. If you have access to a supervised laboratory facility, you may complete Part A of these investigations. If you do not have access, Part B will provide you with an alternate pathway.

Visual Cues

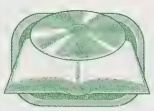
You will find many visual cues throughout this course. Colour is used to highlight the important terms that are defined in the Glossary of the Appendix. You will also encounter some icons in the margins. Read the following explanations to find out what each icon prompts you to do.



Refer to the textbook.



Refer to the multimedia CD given in Module 1.



Refer to the multimedia CD given in the textbook.

Use the Internet.
Note: Any website given is subject to change.

Pay special attention to the safety precautions mentioned.

Answer questions in the Assignment Booklet.

Module Overview

What does the grassfire in the photograph have in common with the rusting cars in the other photographs? Both are examples of a chemical reaction of oxygen with some other substance. In the case of the grassfire, oxygen is combining with the carbon in the blades and stems of the grass. In the cases of the rusting cars, oxygen is combining with the iron in the car.

The properties of the substances involved determine the kind of reaction that occurs. There are thousands of reactions that can occur between the different chemicals known to everybody.

In this module you will study the properties of chemicals. You will study how the classification of these chemicals has helped scientists understand all the different chemicals and chemical reactions that occur. You will discover that chemicals are not just something you find in the laboratory, but are present in everything you see around you. You will come to realize that chemicals play an important role in the world around you. Because of this, you will also need to learn how to handle chemicals safely at work, at school, and at home.

Assessment and Feedback

This module, Investigating Properties of Matter, has four sections. Within each section, your work is grouped into lessons. Within the lessons, there are readings, activities, investigations, and questions for you to do. By completing these lessons, you will discover scientific concepts and skills, practise or apply what you have learned, and develop a positive attitude toward science.

Suggested answers to the questions are provided in the Appendix of this Student Module Booklet. They will provide you with immediate feedback to the questions you complete in the lessons.

At several points in this Student Module Booklet, you will be directed to the accompanying Assignment Booklets. Your grading in this module is based on the assignments you submit for assessment. In this module you are expected to complete four section assignments.

The mark distribution is as follows:

Assignment Booklet 1A	
Section 1 Assignment	38 marks
Section 2 Assignment	38 marks
Assignment Booklet 1B	
Section 3 Assignment	33 marks
Section 4 Assignment	46 marks
Total	**155 marks**

You will be asked to submit each Assignment Booklet to your teacher once it is completed. Your teacher will then mark your Assignment Booklet and give you feedback as to how you are doing. Once you get your Assignment Booklet back, be sure you review your teacher's comments and correct any errors you made.

Section 1

UNDERSTANDING MATTER

What do you think of when the word *chemical* is mentioned? Do you think of the chemicals used in agriculture to spray weeds? Do you think of those used to spray for mosquitoes in the spring? Did you know that water is a chemical? To scientists, all substances are chemicals—some harmful and others vital to all existence.

In this section you will interpret safety information for chemicals used at work and at home. You will learn why it is dangerous to mix some common household substances. You will then discover what all matter has in common, and you will identify the three states of matter. Finally, you will discover the differences between a chemical property and physical property and be able to tell the difference between a pure substance and a mixture.

Lesson 1

Chemicals All Around Us

Kitchens and bathrooms often need strong cleaning products. Have you recently used a product that had a warning label on it? Did you understand the meaning of the label? Many commonly used substances have warning labels on them. In this lesson you will investigate substances used at home and in the workplace and the warning labels that appear for each.

Turn to page 6 of the textbook and read the introductory paragraphs of "Chemicals All Around Us."

1. List three substances you used today or within the last few days that contain chemicals.

2. Does the word *chemical* apply only to substances that are used to kill insects or weeds?

3. Some substances are safe to use; others are dangerous; some pose a hazard when mixed. Some common household materials are dangerous. Study Table 1.1 on page 6 of the textbook. List three household materials that are dangerous when ingested or in contact with your skin.

CHECK Check your answers on page 89 of the Appendix.

Starting Point
Activity

When Substances React

Read the entire activity on page 5 of the textbook.

If you have access to a supervised laboratory, complete the activity. Refer to the list of required materials and follow the instructions carefully. **Pay special attention to the precautions mentioned.**

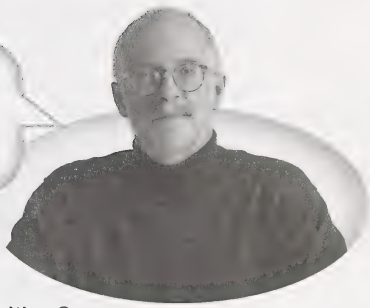
If you do not have access to a supervised laboratory, use the following data and results to answer the questions that follow.

Substance	Appearance at Start of Activity	Appearance at End of Activity	Other Results Noticed
calcium chloride	white powder	mixture turns yellow	• mixture bubbled, foamed, and turned from red to yellow • temperature increased and bag expanded slightly
sodium bicarbonate	white powder	mixture turns yellow	same as for calcium chloride
phenol red indicator	red liquid	mixture turns yellow	same as for calcium chloride

4. Answer questions 1 and 2 of "What Did You Discover?"

5. What do you think would happen if you used large amounts of each substance in the previous activity?

Check your answers on page 89 of the Appendix.



6. What do you think should be done with resulting chemical mixtures created in lab activities?

Check your answer on page 89 of the Appendix.

Since some materials are dangerous, you need to know how to store or dispose of these materials or their containers safely. Turn to page 7 of the textbook and read "Chemical Storage and Disposal."

7. Name three substances that may be around your home that require special storage or disposal.

8. What can be done with products that require special disposal?

Check your answers on page 90 of the Appendix.

Look at the labels of some household products in your home, such as oven cleaner, toilet cleaner, bleach, or paint thinner. Is there a warning stated as well as a special symbol on the label? All hazardous chemicals used at work, in a school laboratory, and in the home have a label stating the risks the substance may present. These labels also explain the precautions that should be followed and all first-aid actions that should be administered if the substance contacts your skin or is swallowed.

There are eight symbols specifically for workplace hazardous materials and nine similar, but more common, symbols for household hazardous products. The information regarding chemicals in the workplace and in schools is called WHMIS. It stands for Workplace Hazardous Materials Information System. The information regarding the symbols for products used at home is called HHPS. It stands for Hazardous Household Product Symbols.

Learn more about WHMIS symbols and WHMIS in the workplace. Insert the *Science.Connect 1 Student Multimedia* CD into your computer. Launch the applet *WHMIS* in the WHMIS folder, and follow the instructions.

9. What are the three elements of WHMIS?

10. What hazards do the following types of materials pose? Give an example of each.

    a. oxidizing materials

    b. substances that have immediate and serious toxic effects

11. List three types of workers who need WHMIS training.

Check your answers on page 90 of the Appendix.

Read "Chemicals at Work and School" on page 8 of the textbook. Read the WHMIS label for toluene closely.

12. Describe the three ways in which information is provided through the WHMIS system.

13. According to the symbols on the label for toluene, what hazards does this chemical present?

CHECK Check your answers on page 90 of the Appendix.

Study the following WHMIS symbols and the short description for each.

Find Out
Activity

A Closer Look at WHMIS

Read the activity on page 8 of the textbook carefully.

Use the MSDS (Material Safety Data Sheet) given at the back of the Appendix and the following WHMIS label to complete this activity.

Calcium Chloride Anhydrous
Chlorure de Calcium Anhydre

THIS IS NOT A CONTROLLED SUBSTANCE

Normal precautions should be taken to minimize any exposure to this or any chemical. Handling care generally in keeping with safe laboratory practice is recommended.

MATERIAL SAFETY DATA SHEET IS AVAILABLE

CECI N'EST PAS UN PRODUIT CONTROLÉ

Des précautions usuelles devraient être prise pour

14. a. What is the chemical name of this substance?

    b. How should this substance be stored?

    c. Is there a fire hazard when this substance is used?

    d. How should a spill be cleaned up?

    e. What are the medical effects of this substance?

    f. What is the recommended first aid if you are exposed to this substance?

15. Answer questions 1, 2, and 3 of "What Did You Find Out?"

Check your answers on pages 90 and 91 of the Appendix.

The Hazardous Household Product Symbols (HHPS) are made up of four symbols. These symbols represent poisonous, flammable, explosive, and corrosive material. Each of these is given a degree of severity using symbols that are similar to traffic signs.

Turn to page 9 of the textbook and read "Chemicals at Home." Carefully study the twelve symbols used for household or consumer products.

16. A substance has a corrosive symbol with the triangular shape surrounding it. Another has a corrosive symbol with the octagonal shape surrounding it.

What is the difference between these two substances?

17. Find a home product with a label on it. Does the label provide safety, first-aid, and disposal information?

CHECK Check your answers on page 91 of the Appendix.

You have now completed the concepts for this lesson. To further your understanding, answer the following questions.

18. Complete questions 1 to 4 "Check Your Understanding" on page 9 of the textbook.

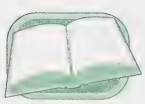
CHECK Check your answers on page 92 of the Appendix.

Go to ... Go to pages 1 to 3 of Assignment Booklet 1A and answer questions 1 to 6.

Lesson 2

Describing Matter

Have you enlarged a photograph on your computer until you can see the dots that make up the picture? Photographs are made up of tiny dots that look solid when they are close together. They become visible when they are enlarged. Scientists have developed a theory that describes matter as being made up of tiny particles, similar to the dots in an enlarged photograph.



Turn to page 10 of the textbook and read the introductory paragraphs of "Describing Matter." Then read the bulleted statements that describe the Particle Theory of Matter.

1. How do scientists describe matter?

2. Which of the following is made up of matter?

   - water
   - a glass you drink from
   - your textbook
   - the air you breathe

3. What does the particle theory state about the spaces between particles in solids, liquids, and gases?

4. Predict which state of matter (solid, liquid, or gas) would have the greatest distance between particles.

5. How many states of water are you familiar with?

Check your answers on page 93 of the Appendix.

The three states of water that were described in the answer to question 5 are solid, liquid, and gas. To learn more about the three states of matter, turn to page 11 of the textbook and read the "States of Matter." Pay particular attention to the illustrations in Table 1.2.

6. Why does a solid keep its shape?

7. Why does a liquid take the shape of its container?

8. Why does the container holding the gas have a lid?

Check your answers on page 93 of the Appendix.

Sometimes, a substance exists in a form that does not appear to fit any one of the three states of matter. Read "Try This!" on page 11 of the textbook. If you have cornstarch at home, try mixing the specified amount of water and cornstarch together. You can try it with smaller quantities of each if you wish; just make sure you use more cornstarch than water.

9. Answer the following questions.

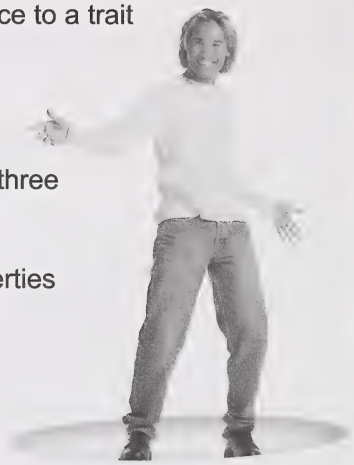
   a. What happens if you rest your finger on the surface of the mixture?

   b. What happens if you poke the mixture?

   c. Is this mixture a solid or a liquid?

Check your answers on page 93 of the Appendix.

The three states of matter are one way in which you can describe matter. Scientists describe matter using a number of physical and chemical properties. You can compare a property of a substance to a trait that helps you recognize something or someone.

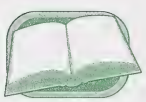


10. a. Pick a person and describe him or her using two lists. In one list, write three things about his or her appearance. In the other list, write three things about his or her behaviour.

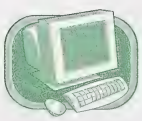
    b. Which list of items is similar to physical properties of a substance?

    c. Which list of items is similar to chemical properties of a substance?

Check your answers on pages 93 and 94 of the Appendix.



Turn to page 12 of the textbook and read "Properties of Matter." This reading will provide information on physical and chemical properties. Pay special attention to the list of physical and chemical properties in Table 1.3.



If you have access to the Internet, do "Internet Connect" on page 12 of the textbook. Follow the instructions given.

11. Write a description for what physical properties and chemical properties include.

Check your answer on page 94 of the Appendix.

Investigation

1-B: Classifying Matter

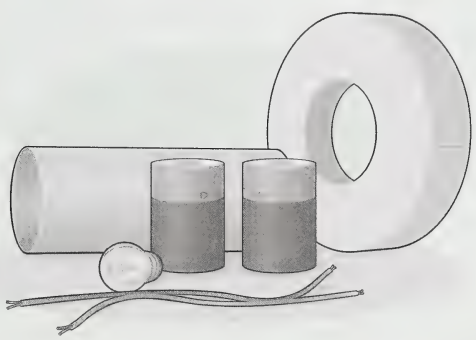
Read the entire investigation on pages 14 and 15 of the textbook.

If you have access to the materials and apparatus listed, do **Part A**. If you do not have access to the materials and apparatus, do **Part B**.

Part A

Pay special attention to the safety precautions mentioned.

One of the items you need for this investigation is a conductivity tester. You can make a simple conductivity tester using a flashlight bulb, copper wire, an empty toilet tissue or paper towel tube, and two 1.5-volt batteries.



The following steps explain how to construct and use a conductivity tester.
Note: If your flashlight bulb is only 1.5 volts (from a miniature flashlight), use only one battery.

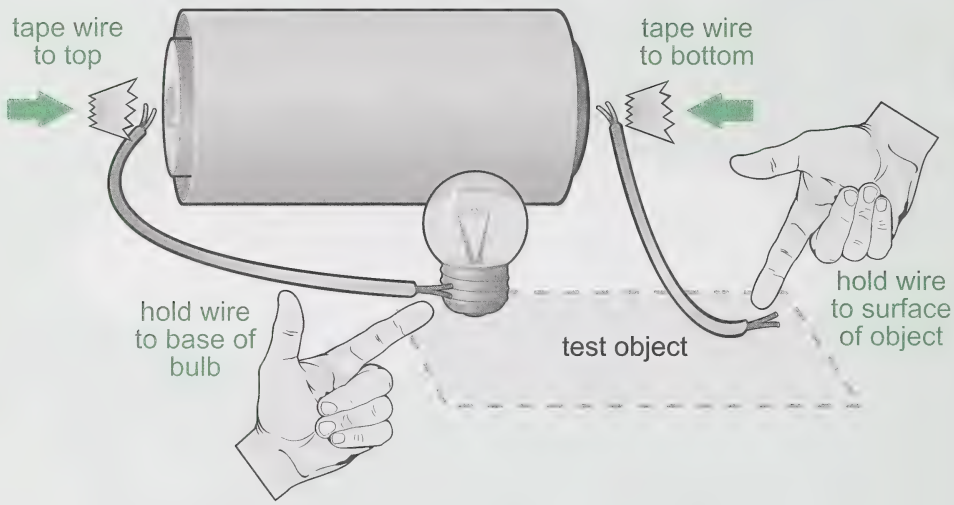
step 1: Strip and clean the ends of two pieces (15 cm to 20 cm in length) of doorbell wire or electrical wire.

step 2: Insert the batteries into the tube, positive to negative. Cut the excess tube. Tape the cleaned end of one of the wires to the top of the batteries and the clean end of the other wire to the bottom of the batteries. Duct tape will work well.

step 3: Hold the free end of one wire against the base of the bulb with one hand and the free end of the other wire with the other hand. Touch the bottom of the bulb to one area of the object to be tested and the other wire to another area.

If the bulb lights up, the material is a conductor. If the bulb does not light up, the material is not a conductor.

Caution: Do not contact the two wires together as the wires can heat up quickly. Also, the battery will heat up and could explode or leak.



Materials and Apparatus:

- conductivity tester
- nail or other sharp object
- magnifying glass
- steel wool or fine sand paper
- penny
- rubber or fibre washer
- plastic spoon
- pen
- magnet
- ruler
- cloth
- loonie
- metal washer
- metal spoon
- pencil
- paper

Design Criteria:

Choose six materials such as those listed. Your classification system should allow you to choose additional materials to be tested.

Plan and Construct:

List a number of properties you might use to classify the materials you have chosen using the apparatus in this investigation.

Design a test for each of the properties you chose.

12. Complete a chart like the following.

Type of Test Material	Conductivity Result	Is the Material Magnetic?	Does the Material Scratch Easily?	Colour	Texture
loonie					
penny					
rubber washer					
plastic spoon					
pen					
cloth					
metal washer					
metal spoon					
pencil					
paper					

13. Use the results of your completed chart to group the materials according to similar characteristics.

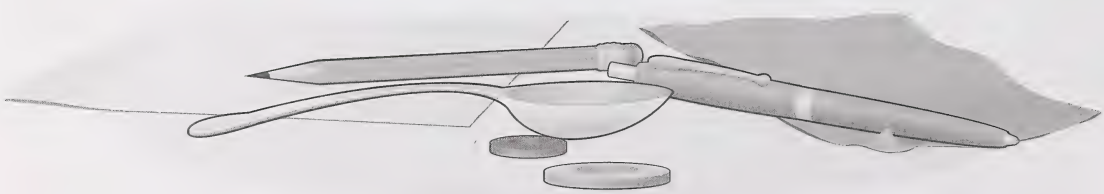
14. Complete questions 1 to 4 of "Evaluate" on page 15 of the textbook.

Check your answers on pages 94 and 95 of the Appendix.

Part B

Use the following table to answer questions 13 and 14 in Part A.

Type of Test Material	Conductivity Result	Is the Material Magnetic?	Does the Material Scratch Easily?	Colour	Texture
loonie	yes	yes	no	bronze	smooth
penny	yes	no	no	brown	smooth
rubber washer	no	no	yes	black	tacky
plastic spoon	no	no	yes	white	smooth
pen	no	no	yes	clear	smooth
cloth	no	no	yes	varies	varies
metal washer	yes	yes	no	silver	smooth
metal spoon	yes	yes	no	silver	smooth
pencil	no	no	yes	yellow	smooth
paper	no	no	yes	white	smooth



You have now completed the concepts for this lesson. To review what you covered, answer the following questions.

15. Complete textbook questions 1 and 4 of "Check Your Understanding" on page 15 of the textbook.

CHECK Check your answers on page 95 of the Appendix.

Go to ... Go to pages 3 and 4 of Assignment Booklet 1A and answer questions 7 to 10.

Lesson 3

Classifying Matter

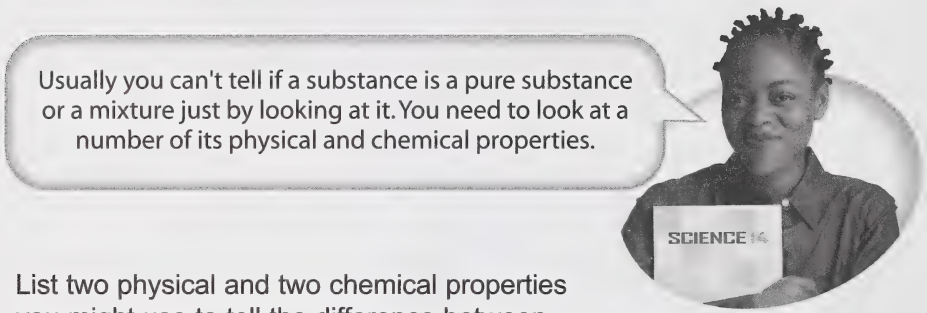
Have you seen a sanding truck spread salt and sand on an icy road? The purpose of adding salt is to make a mixture that will freeze at a temperature lower than 0°C. When salt and sand are added to the ice and water on the road, the result is a mixture that will freeze at a temperature lower than the freezing point of water. The salt that is added to the road surface is not just ordinary sodium chloride. It is usually a mixture of sodium chloride and calcium chloride. Sodium chloride and calcium chloride are pure substances. Together, they are a mixture. Matter can be classified as pure substances or as mixtures.

Turn to page 16 of the textbook and read "Pure Substances and Mixtures." Here you will find the definitions of a **pure substance** and a **mixture**. Then read "Differences Between Mixtures and Pure Substances" on page 17.

1. How does a mixture differ from a pure substance?

2. When a company advertises orange juice as "pure orange juice," is it really a pure substance? Explain.

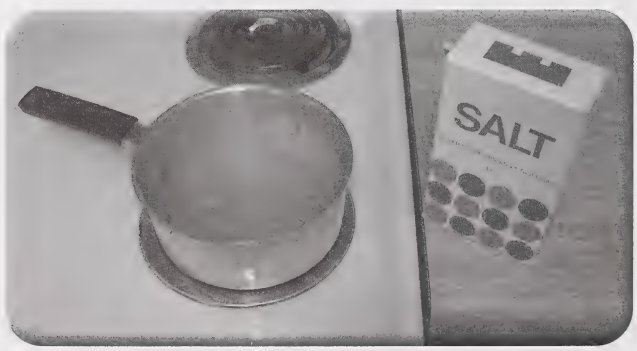
3. Name two items that are pure substances and two items that are mixtures. **Hint:** Look at the labels of several different substances in your home.



4. List two physical and two chemical properties you might use to tell the difference between substances.

CHECK Check your answers on pages 95 and 96 of the Appendix.

The melting point (freezing point) and boiling point of a substance are two important properties scientists often use to tell the difference between substances. In the next investigation you will investigate how salt affects the melting point and boiling point of water.



Investigation

1-C: Melting and Boiling Points

Read the entire investigation on pages 18 and 19 of the textbook.

If you have access to a supervised laboratory, complete **Part A**. If you do not have access to a supervised laboratory, complete **Part B**.

Part A

Complete the investigation as directed on pages 18 and 19 of the textbook.
Pay special attention to the safety precautions mentioned in the textbook.

5. Answer questions 1 and 2 of "Prediction" on page 18.

6. Complete the procedure as outlined on page 18. Set up a chart similar to the following, and record the melting point and boiling point for each mixture.

Beaker	Melting Point	Boiling Point
A (0 g salt)		
B (20 g salt)		
C (40 g salt)		
D (60 g salt)		

7. Draw a graph of amount of salt added versus temperature. You may do both graphs on the same axis. **Note:** If you have access to a computer spreadsheet program, you may enter the table into the spreadsheet and use the Graphing feature to create a graph.

8. Complete questions 1, 2, and 4 of "Analyze" on page 19.

Check your answers on pages 96 and 97 of the Appendix.

Part B

Use the following table to complete questions 7 and 8 from **Part A**.

Beaker	Melting Point	Boiling Point
A (0 g salt)	– 2°C	100°C
B (20 g salt)	– 4°C	102°C
C (40 g salt)	– 5°C	103°C
D (60 g salt)	– 6°C	105°C

Part C: Optional Supplement to Investigation 1-C

If you are working at home and have access to an ordinary outdoor thermometer and ice or snow, you may wish to complete the following supplement to Investigation 1-C. This supplement involves only the freezing (melting) point of a salt and ice-water mixture. You do not need to do **Part C** if you did **Part A**.

Problem: How does salt affect the freezing point of water?

Materials and Apparatus:

- outdoor thermometer, measuring from – 50°C to 50°C
- sour cream or yogurt container (500 mL)
- teaspoon
- salt
- snow or crushed ice

Procedure:

step 1: Fill the sour cream container to about $\frac{3}{4}$ full with snow or crushed ice.

step 2: Add about 50 mL to 100 mL of water to the snow or crushed ice to make a slurry. Place the thermometer into the slurry. Record the temperature when it stops dropping. (Wait for about two minutes after you place the thermometer into the slurry.)

step 3: Add 1 level teaspoon of salt to the slurry and stir thoroughly. Place the thermometer in the mixture and record the temperature after it stops dropping.

step 4: Repeat step 3 three more times.

Observations:

9. Complete a chart similar to the following.

Note: There is a column for adjusted melting points because outdoor thermometers are not always very accurate. Adjust each melting point the same amount as the adjustment of the melting point to 0°C with no salt added.

Number of Teaspoons of Salt Added	Measured Melting Point	Adjusted Melting Point
0		
1		
2		
3		
4		

Conclusion:

10. Did you get a reading of 0°C for the freezing point of ice and water? If not, explain why the reading is not 0°C.

11. Graph the data in the table.

12. What happens to the temperature of the mixture as salt is added?

Check your answers on pages 97 and 98 of the Appendix.

The salt and sand mixture used on roads in cold climates, like in Alberta, contains calcium chloride as well as sodium chloride. Calcium chloride is a salt like sodium chloride except it reacts differently when it comes into contact with water. Calcium chloride releases heat when it reacts with water, whereas the reaction between water and sodium chloride absorbs heat from the surroundings.

This difference is very important when it comes to melting ice on Alberta's highways. If only sodium chloride and sand are used and the temperature is well below the freezing point of water (about – 10°C), no water will be available for the sodium chloride to dissolve. As a result, no mixture that can freeze below 0°C is formed. Also, as the salt dissolves, the temperature of the solution is further decreased since the reaction of salt mixing with water absorbs heat.

Heat is required to start the process by melting some ice to produce water. This heat can come from a number of sources, such as the Sun, friction of vehicle tires, or a chemical (like calcium chloride). Once there is some water on the ice, sodium chloride will dissolve in it to form a mixture that freezes (melts) at a temperature well below 0°C. The more calcium chloride and sodium chloride that is added, the lower the freezing (melting) temperature of the mixture (to a minimum of about – 25°C).

You might ask why road crews don't use only calcium chloride and sand. The reason is that calcium chloride is far more expensive than sodium chloride. Therefore, a small amount of calcium chloride added to the mixture of sodium chloride and sand will result in a mixture that melts ice at a temperature below 0°C.

If you have access to sidewalk de-icer, try the following activity. Sidewalk de-icer contains calcium chloride.

Activity

Using Salt De-icer to Melt Ice Cubes

Problem: Compare the ability of pure salt and sidewalk de-icer to melt an ice cube in cold temperatures.

Materials and Apparatus:

- two containers (e.g., sour cream containers)
- two ice cubes (Freeze about 100 mL of water in each container.)
- sodium chloride (salt)
- sidewalk de-icer

Procedure:

step 1: Place an ice cube in each container, and place the containers in the freezer for at least 2 h.

step 2: Place a teaspoon of salt (sodium chloride) and a teaspoon of de-icer (calcium chloride) in separate plastic bags in the the freezer for the same amount of time as the ice cubes.

step 3: Place a teaspoon of sodium chloride on one ice cube, and place a teaspoon of sidewalk de-icer on the other ice cube. Put a cover on each sour cream container so you don't accidentally spill calcium chloride or salt in the freezer.

step 4: Leave both containers in the freezer for 0.5 h.

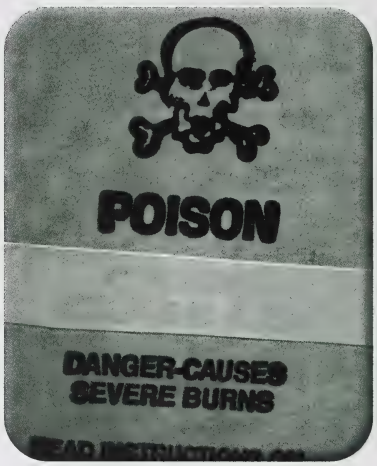
13. Describe what you saw on each ice cube after 0.5 h.

14. What does this activity tell you about the difference between what occurs when you put sodium chloride on ice and when you put de-icer (calcium chloride) on ice?

Check your answers on page 98 of the Appendix.

Section 1 Review

In this section you interpreted safety information for chemicals used at work and at home and learned why it is dangerous to mix common household substances. You discovered what all matter have in common and identified the three states of matter. You then discovered the difference between chemical properties and physical properties, and you used that information to tell the difference between a pure substance and a mixture. You saw that different freezing points (melting points) and boiling points can be used to differentiate between some mixtures and pure substances.



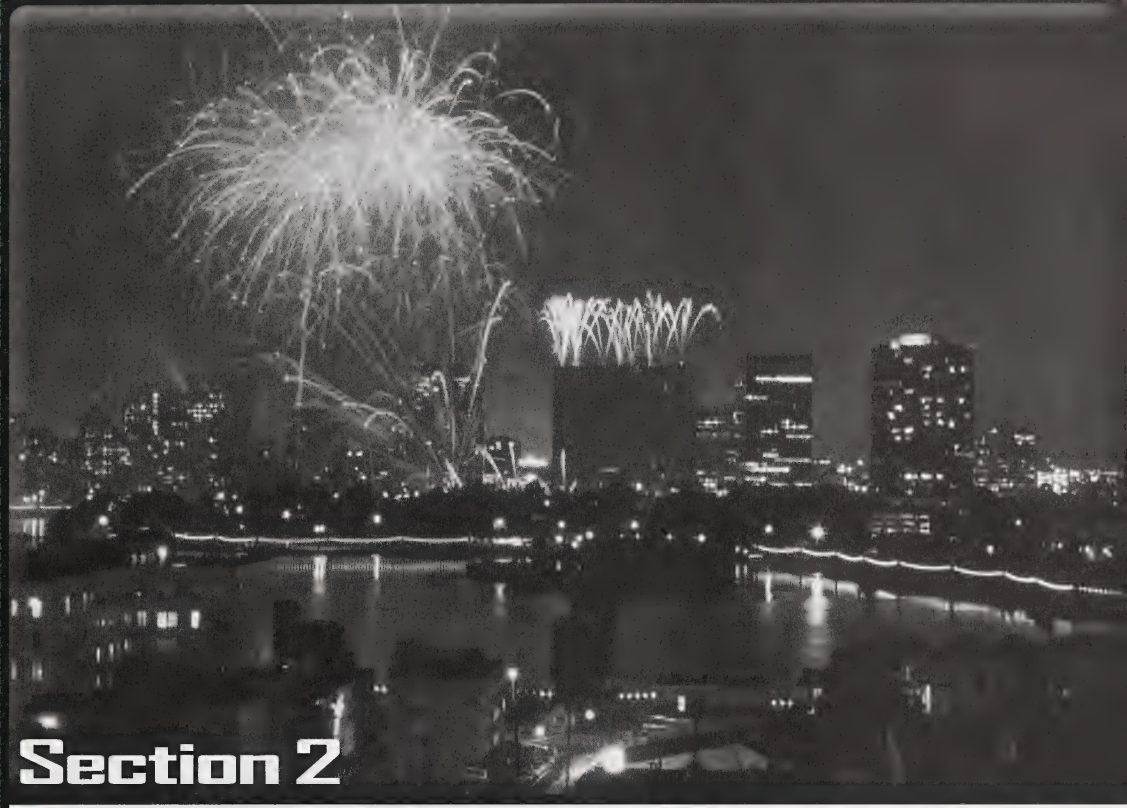
Now, you should have a better understanding of the precautions required when using pesticides or herbicides in agriculture or in your own backyard. You can use safety information to decide if you will use pesticides or herbicides. If you use pesticides or herbicides, you have a responsibility to know how to use these products safely and how to dispose of the empty containers.

You have now completed the concepts for this section. To review what you studied, answer the following "Chapter 1 Review" questions on pages 20 and 21 of the textbook. If necessary, go back and read over parts of this section while you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."
2. Answer questions 3, 4, and 8 of "Understanding Key Ideas."
3. Answer question 17 of "Critical Thinking."

CHECK Check your answers on pages 98 and 99 of the Appendix.

Go to ... Go to pages 4 and 5 of Assignment Booklet 1A and answer questions 11 to 16.



Section 2

PURE SUBSTANCES: ELEMENTS AND COMPOUNDS

What do some fertilizers, matches, and fireworks have in common? These items all contain the element phosphorus. Phosphorus was discovered by accident by an alchemist who was trying to make gold from urine. Now, it is one of the many well-known elements. Fertilizers, matches, and fireworks are all made of several types of particles or elements.

In this section you will look more closely at the types of particles that make up matter and discover ways in which these particles can be organized and combined. You will learn that substances can be divided into two categories based on the number of types of particles they contain.

Lesson 1

Putting the Pieces Together

The ancient Greeks thought that matter was made up of only four substances: earth, air, fire, and water. Later, people knew about substances like carbon (charcoal), gold, silver, lead, and iron. By the mid-1860s, scientists had discovered 64 elements. Today, the properties for 112 elements are known and have been organized into a table, known as the periodic table.

The ancient philosophy of alchemy was practised before scientists knew much about elements. Alchemists thought they could turn inexpensive substances into gold. To learn about the alchemist, read the introduction to Chapter 2 on page 22 of the textbook.

If you have access to a supervised lab, do the Starting Point Activity on page 23. This activity shows you how you can practise alchemy and change the physical appearance of a penny so it looks like gold.

Dmitri Mendeleev was the first scientist to organize the elements known in his time. To see how Mendeleev first organized the known elements, read the introductory paragraphs of "Putting the Pieces Together" on page 24 of the textbook.

1. What did Dmitri Mendeleev do so he could organize the known elements into groups?

2. How did Mendeleev organize the elements within each group?

3. How did Mendeleev organize the groups of elements?

4. The elements in Mendeleev's chart and the modern periodic table are made up of atoms. Which atoms make up water?

Check your answers on page 100 of the Appendix.

You can see a copy of Mendeleev's periodic table at the following Internet site:

http://chemlab.pc.maricopa.edu/periodic/foldedtable.html

Mendeleev's periodic table led to the creation of the modern periodic table. The table shown on page 25 of the textbook is only part of the modern periodic table and contains the first 72 elements. A complete Periodic Table is given inside the back cover of the textbook.

Read "The Periodic Table" on pages 24 and 25 of the textbook. Study the periodic table on page 25 closely.

5. a. How many groups are in the periodic table on page 25 of the textbook?

   b. How many periods are in the periodic table on page 25 of the textbook?

6. What do all periodic tables have in common?

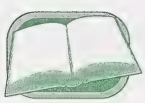
7. What information about an element is contained in each square in the periodic table on page 25?

8. How many elements are in there in Period 2?

Check your answers on page 100 of the Appendix.

A dark line running in staircase fashion from Period 2, Group 12 to Period 6, Group 16 separates the elements of the periodic table into two groups called metals and non-metals. The elements to the left of the staircase are metals, and the elements to the right of the staircase are non-metals.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn

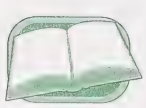


Turn to page 26 of the textbook and read "Metals and Non-Metals." You will be given information about the properties of metals and non-metals.

9. List the properties of metals and the properties of non-metals.

10. In the periodic table on page 25 of the textbook, the blue squares represent elements that are definitely metals and the yellow squares represent elements that are definitely non-metals. Why are some of the squares along the staircase white? What are the elements represented by these squares called?

Check your answers on pages 100 and 101 of the Appendix.



You are most likely familiar with the metals shown on page 26. Read "Did You Know?" and "Off the Wall" on page 27 of the textbook. You will learn about two less-familiar metals and one dangerous non-metal.

Investigation

2-A: Reading the Periodic Table

Read the entire investigation on page 28 of the textbook.

11. Copy and complete a chart like the one on page 28. Use the periodic table inside the back cover of the textbook to complete this chart.

12. Answer questions 1 to 4 of "Analyze" on page 28.

Check your answers on page 101 of the Appendix.

Now that you have some understanding of the location of metals and non-metals in the periodic table, you will complete an investigation involving the properties of metals and non-metals. It is the properties of a substance that allow you to distinguish one substance from another.

Investigation

2-B: Properties of Metals and Non-Metals

If you have access to a supervised laboratory facility, complete **Part A**. If you do not have access to a supervised laboratory facility, complete **Part B**.

Part A

Turn to page 29 of the textbook and read the entire investigation.

Complete the investigation as directed. **Note:** The lab facility may not be able to test nitrogen. So, you may skip this part of the investigation. Also, you will not need a magnet for this investigation.

Pay careful attention to the safety precautions mentioned.

13. Explain the safety precautions required for this investigation.

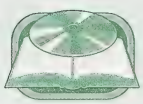
14. Complete questions 1 to 7 of "Plan and Construct" on page 29 of the textbook. **Caution:** Lead should not be rubbed with steel wool because hazardous particles can result. You may scratch the lead sample with a metal object, like a nail.

15. a. Answer questions 2, 3, and 4 of "Evaluate."

    b. Answer question 5 of "Extend Your Skills."

Check your answers on pages 101 to 104 of the Appendix.

Part B



Insert the *Science.Focus 1 Student Multimedia* CD into your computer. Launch the *PT* applet in the Periodic_Table folder. Follow the instructions on the CD to complete Parts 1 to 10. Then answer the questions that follow.

16. Which two substances were tested in the Properties of Metals and Properties of Non-metals parts?

17. What tests were used on the substances that were tested in the procedure?

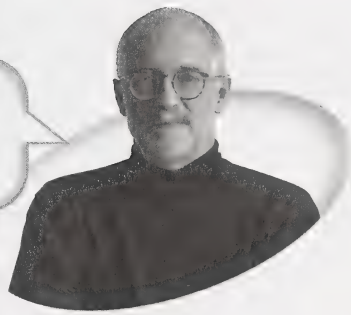
18. Write out a procedure for testing each of the properties.

19. State the safety precautions that were followed by the students who demonstrated the tests.

20. List three properties of a metal and three properties of a non-metal.

21. State the trend that has been used by scientists to provide a clue to the structure of the atom.

Check your answers on pages 104 and 105 of the Appendix.



You have now completed the concepts for this lesson. To review what you covered, answer the following questions.

22. Answer question 2 of "Check Your Understanding" on page 30 of the textbook.

CHECK Check your answers on page 105 of the Appendix.

Go to ... Go to pages 6 and 7 of Assignment Booklet 1A and answer questions 1 to 6.

Lesson 2

Elements and Compounds

Your body is composed of blood, tissues, bones, water, and various other substances. Are these substances elements or compounds? What makes up blood? Blood is made up of white cells, red cells, and fluid. Your body is composed of various elements and compounds.

Everything around you is made up of elements and compounds. The periodic table at the back of the textbook lists all the elements known to scientists. Compounds are made up of two or more elements chemically combined together. Examples of elements are hydrogen, oxygen, gold, iron, and zinc. Examples of compounds are distilled water, sodium hydroxide, and hydrogen peroxide. Elements and compounds can be compared to letters and words. Just like words are made up of letters, compounds are made up of elements.

Turn to pages 30 and 31 of the textbook and read "Elements and Compounds in Society" and "Compounds." Study the organizational chart (Figure 2.9) on page 31.

1. What is an element?

2. What is a compound?

3. In the organizational chart on page 31, why are both elements and compounds under the heading Pure Substances?

Check your answers on page 105 of the Appendix.

Since compounds are made up of two or more elements, it is reasonable to assume that compounds can be broken down into its simpler substances. The chemical process of breaking down compounds into simpler substances is called a **decomposition reaction**. The following investigation is an example of a common decomposition reaction.

Investigation

2-C: Decomposition Reaction

Turn to pages 32 and 33 and read the entire investigation to get a general idea about the investigation.

4. What predictions can you make about what happens when electricity is passed through water?

5. Why are the safety precautions for this investigation necessary?

Check your answers on page 105 of the Appendix.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A

Complete the investigation as directed in the textbook. Record your results as you complete the procedure.

Caution: The flame test described in the steps 11 and 12 of the procedure on page 33 are safe only for small amounts of hydrogen and oxygen gas (as is produced in this investigation).

If your lab supervisor has not prepared your sodium sulfate solution, you will need to prepare about 500 mL of sodium sulfate solution. You need 300 mL for the beaker and 50 mL for each test tube. You will need a 500 mL beaker in which to make this solution. You can put 3 mL of sodium sulfate into 500 mL of water.

6. Answer the following on page 33 of the textbook.

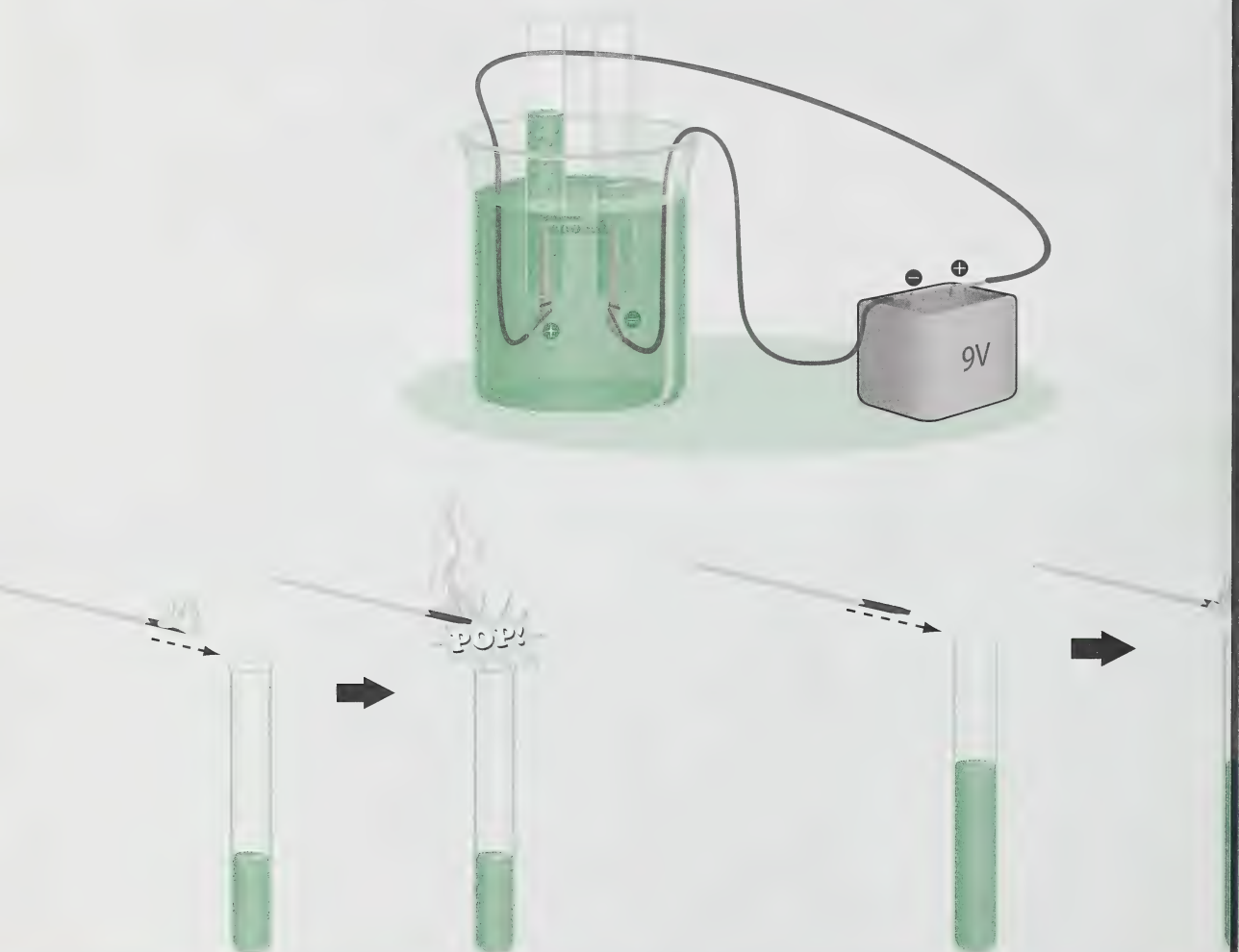
    a. questions 1, 2, and 3 of "Analyze"

    b. questions 4 and 5 of "Conclude and Apply"

CHECK Check your answers on page 106 of the Appendix.

Part B

Study the following diagrams that show the results of a student who performed Investigation 2-C. Then answer question 6 in **Part A**.



There are other decomposition reactions that occur in everyday situations. To discover two additional decomposition reactions, read "Did You Know?" on page 34 of the textbook.

You have now completed the concepts for this lesson. To further your understanding, answer the following questions.

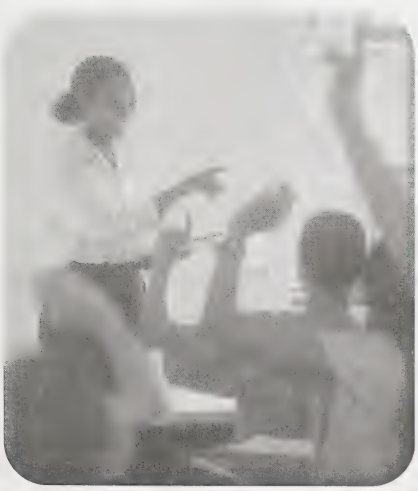
7. Answer textbook questions 1 and 4 of "Check Your Understanding" on page 34 of the textbook.

CHECK Check your answers on page 107 of the Appendix.

Go to ... Go to pages 7 and 8 of Assignment Booklet 1A and answer questions 7 to 14.

Lesson 3

Chemical Names and Formulas



What would happen if everybody had a different name for everybody else? For instance, Riley is known by the name of Thomas by one friend, Alex by another friend, and Sean by his teacher. Now, suppose the teacher wanted to know where Sean was and asked Riley's friends. Well, Riley's friends don't know him as Sean. They would be confused as to whom the teacher is referring. Now, imagine if this were true for everybody. Communication would be next to impossible.

The same is true for chemicals. Everyone who works with chemicals must also know the elements by the same name and symbol. This way, people from all over the world can communicate information about elements to one another.

Chemists have established a group known as the International Union of Pure and Applied Chemistry (IUPAC). They have agreed on common symbols for all the elements. To learn about some of the names and symbols that chemists set up for the elements, read the introductory information of "Chemical Names and Formulas" on page 35 of the textbook.

1. Is the name and spelling used for hydrogen the same in all the languages listed in Table 2.2?

2. Is the chemical symbol used for hydrogen the same in all the languages listed in Table 2.2?

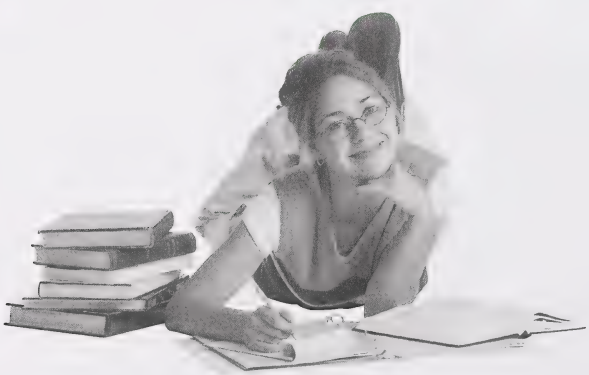
3. What conclusion might you draw from Table 2.2 about the names and symbols of the elements in different languages?

4. How were the symbols for carbon and nitrogen picked?

5. Why is the symbol "C" not used for calcium?

6. Why is the symbol for lead "Pb" rather than "Le"?

Check your answers on page 107 of the Appendix.



People often use short forms for communication. You are most likely familiar with postal codes, abbreviations for titles (e.g., Mr. and Mrs.), and abbreviations for words (e.g., St. and Ave). In chemistry, the chemical formulas that identify elements and compounds are made up of letters and numbers.

Turn to page 36 of the textbook and read "Chemical Formulas." Pay special attention to Figure 2.13 and Table 2.3.

7. Table 2.3 lists a number of chemical compounds and their corresponding chemical formulas. State what each part of the symbol for hydrogen peroxide, $H_2O_{2(\ell)}$, represents.

8. How is the formula for hydrogen peroxide ($H_2O_{2(\ell)}$) different from the formula for water $H_2O_{(\ell)}$?

9. How many atoms are in the formula for hydrogen peroxide ($H_2O_{2(\ell)}$)? How many atoms are in the formula for water ($H_2O_{(\ell)}$)?

10. What do the following tell you about the chemical formula?

    a. letters of the formula

    b. subscript numbers in the formula

    c. subscript letters in the formula

CHECK Check your answers on pages 107 and 108 of the Appendix.

The chemical formula for pure water is $H_2O_{(\ell)}$. The formula $H_2O_{(\ell)}$ means water is made up of hydrogen and oxygen. It also means that there are two atoms of hydrogen for every atom of oxygen. This formula has a total of three atoms.

The formula for sodium chloride (table salt) is NaCl. This means that sodium chloride is made up of sodium and chlorine and that there is one atom of sodium for every atom of chlorine. This formula has a total of two atoms.

Formulas for other compounds can be more complex. It is important to be able to interpret a chemical formula. In the following activity you will interpret the formulas of a number of common substances.

Find Out
Activity

Interpreting Chemical Formulas

Turn to page 37 of the textbook and read the entire activity.

11. Complete the table by following the steps in "What to Do." You will need to refer to the periodic table at the back of the textbook for the element names.

12. Answer questions 1 and 2 of "What Did You Find Out?"

CHECK Check your answers on pages 108 and 109 of the Appendix.

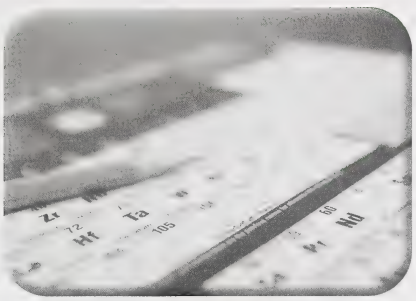
Chemical symbols and formula provide you with a shorthand way of writing elements and compounds. Scientists use the same symbols and rules for writing the names of the elements and compounds so other scientists throughout the world can understand what is written.

You have now completed the concepts for this lesson. To further your understanding, answer the following questions.

13. Answer questions 1 and 3 of "Check Your Understanding" on page 37 of the textbook.

CHECK Check your answers on page 109 of the Appendix.

Section 2 Review



In this section you looked at the types of particles that make up matter and discovered ways in which these particles can be organized and combined. You learned that substances can be divided into two categories: elements and compounds. You also discovered that people use the same symbols and rules for writing the names of chemicals throughout the world.

The study of compounds has enabled you to know what different materials (such as fertilizer, matches, and fireworks) have in common. Phosphorus—an element that is used to make fertilizer, matches, and fireworks—is just one of the 112 elements you can learn about.

You have just completed Section 2 of this module. To review the concepts presented in this section, do the following "Unit 2 Review" questions on pages 38 and 39 of the textbook. If necessary, go back and read parts of this section as you answer these questions.

1. Answer questions 1 and 3 of "Reviewing Key Terms."
2. Answer question 5 of "Understanding Key Ideas."
3. Answer question 8 of "Developing Skills."
4. Answer questions 10 and 14 of "Problem Solving/Applying." **Note:** For question 10, select only one element or compound for each product.

CHECK Check your answers on pages 109 and 110 of the Appendix.

Go to ... Go to pages 9 and 10 of Assignment Booklet 1A and answer questions 15 to 21.

Section 3

MIXTURES AND THEIR USES

The pillars in the photograph are made of steel and concrete. Concrete is a mixture of water, sand, gravel, and cement. If you look at concrete as it is being poured, you can see the different particle sizes present. You can see the sand, the gravel, and maybe the water (which may separate out if too much is added) that make up the mixture. The cement is less noticeable in the mixture but can be recognized as the grey colour. A mixture like this is known as a mechanical mixture.

In this section you will identify mechanical mixtures and solutions and recognize the differences between them. You will separate mechanical mixtures and solutions and identify the parts of a solution. You will discover why some substances are soluble and others not. You will describe the concentration of a solution and determine how temperature affects solubility.

Lesson 1

Two Kinds of Mixtures

In Sections 1 and 2 of this module you recognized matter as being either a pure substance or a mixture. You then described pure substances as elements or compounds. In this lesson you will study mixtures as mechanical mixtures and as solutions. You will compare mechanical mixtures and solutions and recognize the differences between the two types of mixtures. You will also identify the parts of a solution.

In the photo there are two glasses: one filled with orange juice, the other with a sugar-water mixture. Generally, in a glass of orange juice, you can see the pulp. This mixture is an example of a **mechanical mixture**. In the glass with the sugar-water mixture, you cannot see the dissolved sugar. This mixture is an example of a **solution**.

Turn to pages 40 and 41 of the textbook and read the Chapter 3 introduction. Pay particular attention to the information in "What You Will Learn," "Why It Is Important," and "Skills You Will Use."

1. What were three categories of water mentioned?

2. What material might you be able to separate from dirty water using a paper or cloth filter?

CHECK Check your answers on page 111 of the Appendix.

Separating different kinds of debris from dirty water (as in question 2) is an example of separating a mechanical mixture. In the next activity you will separate dry and wet mechanical mixtures.

Starting Point
Activity

Separating a Mechanical Mixture

Turn to page 41 of the textbook and read over the activity.

Obtain the required materials, and complete the activity as directed in "What to Do." If you do not have iron filings, you can use small nails or cut up some steel wool. Use tin snips or an old pair of scissors to cut up the steel wool. You can make a funnel by cutting a 2-L plastic pop bottle in half. Use a coffee filter or a piece of cloth as the filter paper. Put the magnet in a plastic bag to keep it from getting fouled up with iron filings.

Caution: Exercise care when cutting materials.

3. Write a lab report for this activity. Include the following parts in your lab report.

    - Title
    - Problem
    - Materials and Apparatus
    - Procedure
    - Observation (what you saw in steps 5 and 7 of "What to Do")
    - Conclusion (what you think the activity showed you)

CHECK Check your answer on page 111 of the Appendix.

Now, turn to page 42 of the textbook and read the introductory paragraphs of "Two Kinds of Mixtures." Follow this up by reading "Mechanical Mixtures" at the bottom of the page.

4. State the two kinds of mixtures that will be studied in this lesson.

5. How do you know when you are looking at a mechanical mixture?

6. There were two mechanical mixtures in the Starting Point Activity on page 41 of the textbook. What substances made up each of the mechanical mixtures in the activity?

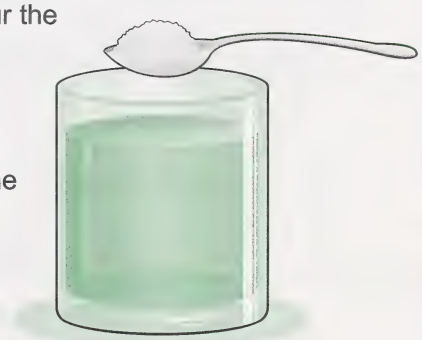
7. Name three mechanical mixtures around your home.

Check your answers on page 111 of the Appendix.

In the Starting Point Activity on page 41 of the textbook, you added sugar as one part of the mixture. However, when you filtered the mixture, you were unable to recognize whether you were able to remove the sugar or whether it stayed behind. In the next activity, you will further analyze a mixture of sugar and water.

Making a Solution

Mix 1 teaspoon of sugar in a glass of water. Stir the mixture until the sugar disappears. Pour the mixture into a second glass through a coffee filter or small piece of cloth.



8. How many substances do you see after you have thoroughly stirred the sugar and water?

9. Can you see any residue on the filter paper or cloth after you have poured the mixture through?

10. Predict what has happened to the sugar that it doesn't filter out.

Check your answers on page 111 of the Appendix.

The mixture you made in the previous activity is called a **solution**. For more information about solutions and some examples, read "Solutions" on page 43 of the textbook.

11. In the sugar and water mixture you made, which is the solute and which is the solvent?

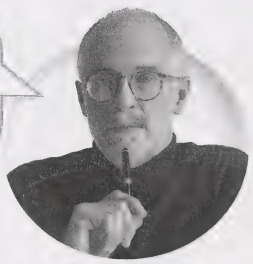
12. Write a definition for *solute* and for *solvent*.

13. Which substance (solute or solvent) is there more of in a solution?

14. When you mixed sugar and water, the solution was colourless. Does a solution always have to be colourless? Give two examples of solutions that are not colourless.

CHECK Check your answers on page 112 of the Appendix.

Now, you will do an activity in which you determine whether some common mixtures are mechanical mixtures or solutions.



Find Out Activity

What Kind of Mixture?

Turn to page 44 of the textbook and read the entire activity.

Pick four of the following mixtures:

- tea (liquid)
- clear apple juice
- sand and water
- milk
- sugar and water
- orange juice
- coffee with grounds
- soda pop

Use the funnel that you made earlier and a coffee filter or cloth as the filter paper.

Follow steps 1 to 6 of "What to Do."

15. Copy and complete a table like the one in step 1.

16. Answer questions 1 and 2 of "What Did You Find Out?"

Check your answers on pages 112 and 113 of the Appendix.

You have now completed the concepts for this lesson. Do the following questions to check your understanding of what you studied.

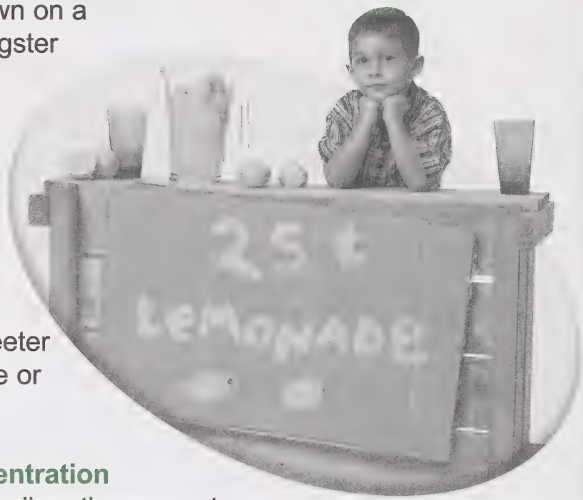
17. Complete questions 1.a., 1.b., 1.c., 2, 3.a., and 3.c. of "Check Your Understanding" on page 44 of the textbook.

Check your answers on page 113 of the Appendix.

Go to pages 1 and 2 of Assignment Booklet 1B and answer questions 1 to 6.

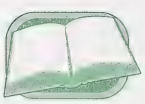
Lesson 2

What Are Solubility and Concentration?



Have you ever roamed around town on a hot summer day and seen a youngster selling lemonade? Was it the real stuff or was it made from the powder? Do you make lemonade or iced tea at home using the store-bought powders? Using the powder is so much easier. Not only are they quicker to make, but you can make individual glasses taste sweeter than others simply by adding more or less powder to the glass of water.

In this lesson you will study **concentration** and **solubility**. Concentration describes the amount of solute in a solution. For lemonade and iced tea, the concentration describes the number of teaspoons of powder you add to the glass of water. For example, a glass of water with two teaspoons of powder has a higher concentration of powder than a glass of water with only one teaspoon of powder. Solubility describes how much solute will dissolve in a solvent at a particular temperature.



Turn to page 45 of the textbook and read the introductory paragraphs of "What Are Solubility and Concentration?"

1. How is concentration defined?

2. How does the manufacturer of Roundup™ show concentration?

3. Write, in your own words, what is meant by the concentration on the Roundup™ label.

Check your answers on page 114 of the Appendix.

Many consumer products show concentration on the label. In the next activity you will examine a number of product labels to see how concentration is shown on the labels.

Find Out Activity

Concentrations of Consumer Products

Turn to page 45 of the textbook and read the information in the activity.

Obtain five products that have their concentrations listed on their labels. These may include foods, varnishes, stains, cleaning products, and fluids for vehicles.

4. State the purpose of this activity.

5. Complete a table as described in step 2 of "What to Do." **Note:** List only one substance in the Solute column. If possible, try and use the main solute. For the solvent, you will find that it is not always stated and that the concentration is given in various forms (e.g., 5.25% and 23 g/100 mL). State the concentration in the form given on the label.

6. Answer questions 1, 2, and 3 of "What Did You Find Out?"

CHECK Check your answers on page 114 of the Appendix.

While concentration is the amount of a solute in a solution, solubility is how easily a solute will dissolve in a solvent. Some substances dissolve easily while others do not dissolve at all.

Activity

Try This!

Turn to page 46 of the textbook and read "Solubility." Study Figure 3.6 carefully.

Now, perform the activity described in "Try This!" on page 46 of the textbook.

7. Why does the oil stay on top of the water?
8. How did the food colouring move through the oil?
9. What happened when the food colouring reached the water?
10. What would happen if you put some oil in the glass first and then added water on top of the oil?
11. What is meant when a substance is said to be soluble in a solvent?
12. What is meant when a substance is said to be insoluble in a solvent?

Check your answers on page 115 of the Appendix.

Do you know anyone who has prepared a sugar and water solution for a hummingbird feeder? Do you know how they get more sugar to dissolve in the water? The next investigation will help you answer these questions.

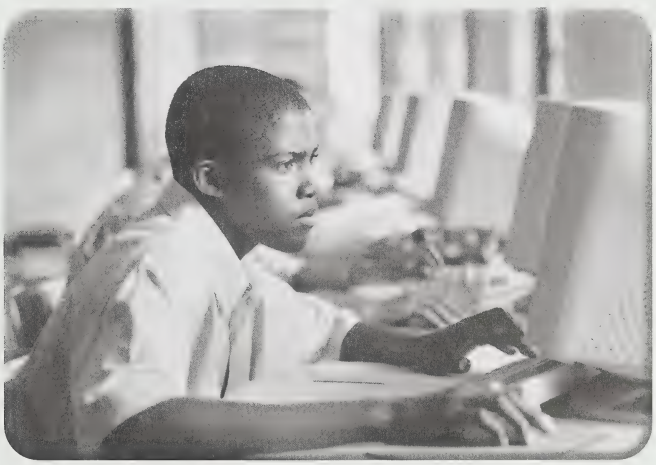
Investigation

3-A: How Does Temperature Affect Solubility?

Turn to page 47 of the textbook and read over the entire investigation.

In this investigation you will draw a graph of the solubility in water versus temperature for three substances. You will then analyze the graphs and make some conclusions about the effect of temperature on solubility.

13. Draw all three graphs on one set of axis. Complete the graph as instructed in steps 1 to 5 of "What to Do." You may draw the graph using graph paper, or you may use a computer spreadsheet program.



14. Complete textbook questions 1, 2, and 3 of "Analyze."

CHECK Check your answers on pages 115 and 116 of the Appendix.

You have just discovered that heating a solution increases the amount of solute that will dissolve in a solvent. However, some substances will not dissolve at all in a particular solvent. The following investigation will tell you which solvent is best to dissolve a particular substance.

Investigation

3-B: What Is the Best Solvent?

Turn to pages 48 and 49 of the textbook and read over the entire investigation.

If you have access to a supervised laboratory, do **Part A**. If you do not have access, do **Part B**.

Part A

Follow the steps of the procedure carefully. **Pay special attention to the safety precautions mentioned.**

15. Complete questions 1, 2, and 3 of "Analyze."

Check your answers on page 116 of the Appendix.

Part B

Complete this investigation with modifications to the apparatus and materials as follows.

Use the stove burner on medium heat. Do not heat the water in the pot to boiling. Use caution when handling the heated cup with a potholder.

Materials and Apparatus Modifications

- Use a stove element in place of the hot plate.
- Use a pot in place of the 100-mL beaker.
- Use a glass measuring cup in place of the 4 test tubes and the 25-mL graduated cylinder.
- Use jar tongs or a pot holder in place of test tube tongs.
- Use spoons in place of the 2 scoopulas and 4 stirring rods.

Procedure Modifications

- Use the glass measuring cup four times in place of using four test tubes.
- Use about 50 mL of water and 50 mL of vegetable oil each time.
- Use about 0.5 teaspoons of salt and 0.5 teaspoons of petroleum jelly.
- Record your results after each part.

Using the modifications given, carefully follow the procedure. Then answer question 15 in Part A.

The previous investigation stated that water is called the universal solvent because it can dissolve many substances. In the investigation you found that it could not dissolve petroleum jelly. Yet, water is used to wash clothes, some of which may have a grease spot on them. Is this one reason why laundry soap is also used to wash clothes?

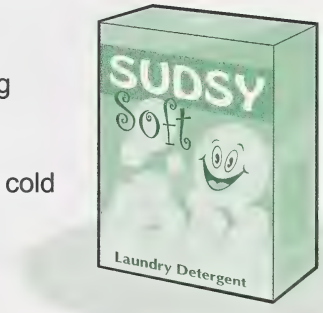
Turn to page 49 of the textbook and read "How Soap Works."

16. What two substances were used in making soap in the past?

17. Explain how clothes are cleaned in a washing machine.

18. Do you think clothes will be washed better in cold water or warm water?

19. If temperature increases the cleaning power of laundry detergent why do most people not use hot water to wash their clothes?



CHECK Check your answers on page 116 of the Appendix.

Go to ... Go to pages 2 to 5 of Assignment Booklet 1B and answer questions 7 to 17.

Lesson 3

Separating Mixtures

You are probably familiar with water from a pond, dugout, or pothole. Usually this water contains various kinds of debris, such as sticks, leaves, and dirt. Water such as this is a mechanical mixture. This dirty water can be separated to give clear water. Be careful, though. Even if the debris is removed, the water may still not be safe to drink. The water is still a solution that could contain bacteria and dissolved chemicals.

There are numerous ways of separating mixtures. In this lesson you will conduct investigations involving two methods of separating mixtures.

Investigation

3-C: Making Dirty Water Clear

Turn to page 51 of the textbook and read the entire investigation.

Follow the instructions given, and design a filter to make a quantity of dirty water clear. If dirty water is unavailable, you can create it by using tap water and adding some soil or dirt to it.

If you are working at home, you will need to make the following changes to the apparatus.

Apparatus Modification

- Use the two parts of the 2-L pop bottle you used in "Starting Point Activity: Separating a Mechanical Mixture" on page 41 of the textbook.
- Use the bottom as a container to obtain approximately 500 mL of dirty water.
- You will need a container, such as an ice cream pail or a large yogurt container, to catch the filtered water.
- Design a means of suspending the filter over a container.
- Use a watch with a second hand in place of a stopwatch.

Follow the instructions in "Plan and Construct."

Remove the template for this investigation on pages T1 and T2 of the Appendix (at the back of the Appendix).

1. Use the template to complete a lab report for Investigation 3-C.
2. Complete questions 1, 2, and 3 of "Evaluate."

Check your answers on pages 117 and 118 of the Appendix.

In the previous investigation you saw that a filter can be used to remove particles from water. Filters can be used in various places to remove unwanted parts of a mixture.

3. Copy and complete the following table.

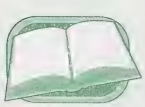
Filter	What It Traps	What Passes Through
furnace filter		clean air (oxygen, nitrogen)
kitchen sieve		
coffee filter		coffee solution
tea bag		
ceramic water filter	bacteria, small particles	
garden sieve		sand and soil

Check your answer on page 118 of the Appendix.

Investigation 3-C involved separating mechanical mixtures. You can also separate solutions. In the following investigation you will remove salt from a salt-water solution.

Investigation

3-D: Get Salt from Salt Water



Turn to pages 52 and 53 of the textbook and read the entire investigation.

If you have access to a supervised laboratory, do **Part A**. If you do not have access, do **Part B**.

Part A

Follow the steps of the procedure to complete this investigation. Your teacher may have the salt-water solution prepared or may provide instructions for you to prepare your own salt-water solution.

Pay careful attention to the safety precautions mentioned.

4. Answer the following on page 53 of the textbook.

   a. questions 1 and 2 of "Analyze"

   b. questions 3 and 4 of "Conclude and Apply"

Check your answers on page 118 of the Appendix.

Part B

If you are working at home, make the following changes to the procedure:

- Prepare a salt-water solution in a small measuring cup by adding about 5 mL (1 teaspoon) of salt to 50 mL of water.

- Use a small cooking pot on the stove to evaporate the water. Keep the heat low. **Use caution when heating**.

- Heat the pot until all the water has evaporated. Do not overheat so as to burn the pot.

Follows the steps of the procedure carefully. Then answer question 4 in Part A.

In the previous investigation you have seen that a salt solution can be evaporated to leave a salt residue. If you had a way to collect the steam that evaporated in this investigation, you would have purified water. The process of heating water to evaporate it and then cooling and collecting the condensed steam is called distillation. This process can be used to purify water. This is fine for a small amount of water, such as for a small glass. However, to purify a large quantity of water for a city by distillation would require a huge amount of energy. Other methods of purifying water are used by towns and cities.

Turn to pages 54 and 55 of the textbook and read "Purifying Water." Pay particular attention to Figure 3.9.

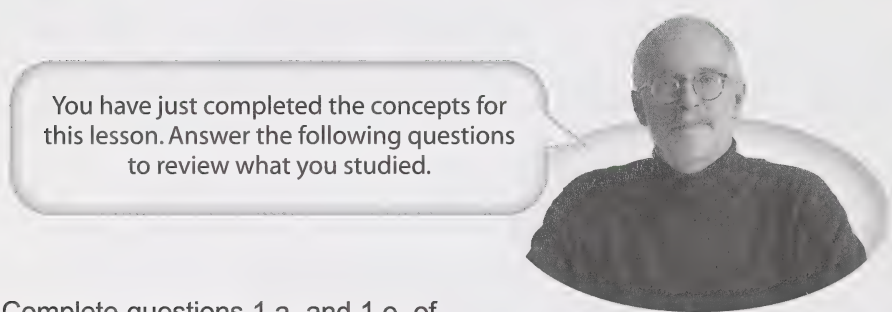
5. Explain how alum is used in the water purification process to remove dirt particles.

6. What two methods are used to remove the dirt-covered alum particles?

7. What is the purpose of adding chlorine in the final stage of the water purification process?

8. Distillation is discussed briefly in the textbook. How does distillation remove bacteria and viruses?

Check your answers on pages 118 and 119 of the Appendix.



9. Complete questions 1.a. and 1.e. of "Check Your Understanding" on page 55 of the textbook.

Check your answers on page 119 of the Appendix.

If you have access to the Internet, turn to page 53 of the textbook and follow the instructions in "Internet Connect." This site will give you information on how the Sun can be used to purify water.

Section 3 Review

In this section you identified and separated mechanical mixtures and solutions. You identified the parts of a solution. You defined solubility and found that some substances are soluble in a particular solvent while others are not. You then described the concentration of a solution and determined the effect of temperature on solubility.

Some mixtures are not obvious, like sugar and water. Other mixtures, such as concrete, have different parts that can be seen. Next time you are walking on the sidewalk or past a concrete building, check if you can see the sand, gravel, and cement particles in the concrete.

You have now completed the concepts for this section. To review what you studied, do the following "Unit 3 Review" questions on pages 56 and 57 of the textbook. If necessary, go back and read over parts of this section as you answer the questions.

1. Answer question 1 of "Reviewing Key Terms."
2. Answer question 4 of "Understanding Key Ideas."
3. Answer questions 6 and 8 of "Developing Skills."
4. Answer questions 10 and 11 of "Problem Solving/Applying."
5. Answer question 15 of "Critical Thinking."

CHECK Check your answers on pages 119 and 120 of the Appendix.

Go to ... Go to pages 5 and 6 of Assignment Booklet 1B and answer questions 18 to 24.

Section 4

SOLUTIONS AND THE ENVIRONMENT

Do you have particular shampoo you like to use? Does your shampoo bottle have the word *concentrated* on it? Do you know why you use a shampoo to wash your hair instead of soap?

In this section you will discover the difference between a concentrated solution and a dilute solution. You will examine why using a concentrated solution may be better for the environment. You will then identify acids and bases using indicators, and you will interpret pH values as a measure of how acidic or how basic a substance is. Finally, you will investigate some factors that affect corrosion.

Lesson 1

Use Concentrated Solutions to Reduce Garbage

Do you drink orange juice? Does your family buy orange juice in 1-L or 2-L containers or in cans of frozen product? Maybe your family buys juice crystals? If you are using frozen orange juice or juice crystals, you are using a concentrated form of orange juice that you need to dilute to make orange juice. If you use 1-L or 2-L containers, you are using a ready-made dilute solution. Which package do you think uses more material?

Concentrated and **dilute** are two terms that are often used to describe various substances. The next activity will help you to understand concentration.

Starting Point
Activity

Tea Time

Turn to page 59 of the textbook and read the entire activity.

Follow the instructions in "What to Do" to complete the activity.

1. Complete a table like the following to record your observations.

Solution	Appearance After Tea Is Added (step 2)	Appearance After Sugar Is Added to Cup 2 (step 4)	Appearance After Lemon Is Added to Cup 1 (step 5)
Cup 1			
Cup 2			
Cup 3			

2. Why is the colour of the tea in Cup 2 lighter than the colour of the tea in Cup 1?

3. Why is the colour of the tea in Cup 3 lighter than the colour of the tea in Cup 2?

4. What does the lighter colour of the tea solution indicate about the concentration of tea in the tea solution?

5. Can colour be used as an approximate indicator of concentration of a tea solution?

6. Can you see a difference in the colour of the tea in Cup 2 after the sugar was added?

7. Can you see a difference in the colour of the tea in Cup 1 after the lemon was added?

8. After the lemon was added, which cup of tea looks to be the most concentrated?

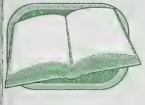
9. Can colour always be used as an indicator of concentration of a tea solution?

Check your answers on page 121 of the Appendix.

Which product do you think would use more packaging—a concentrated product or a dilute product? To answer this question do the next investigation.

Investigation

4-A: How Much Packaging?



Read over the entire investigation on page 61 of the textbook.

Follow the instructions in the investigation, and complete the following questions.
Note: A partner is really not required to do this investigation.

10. Calculate the mass of the packaging per serving for the frozen concentrate and for the drinking boxes. Use the formula given in step 2 of "What to Do?"

11. Calculate the cost of the packaging per serving for the concentrate and for the drinking boxes. Use the formula given in step 3 of "What to Do?"

12. Answer questions 1 to 4 of "Analyze." **Note:** You do not need a partner to complete question 3.

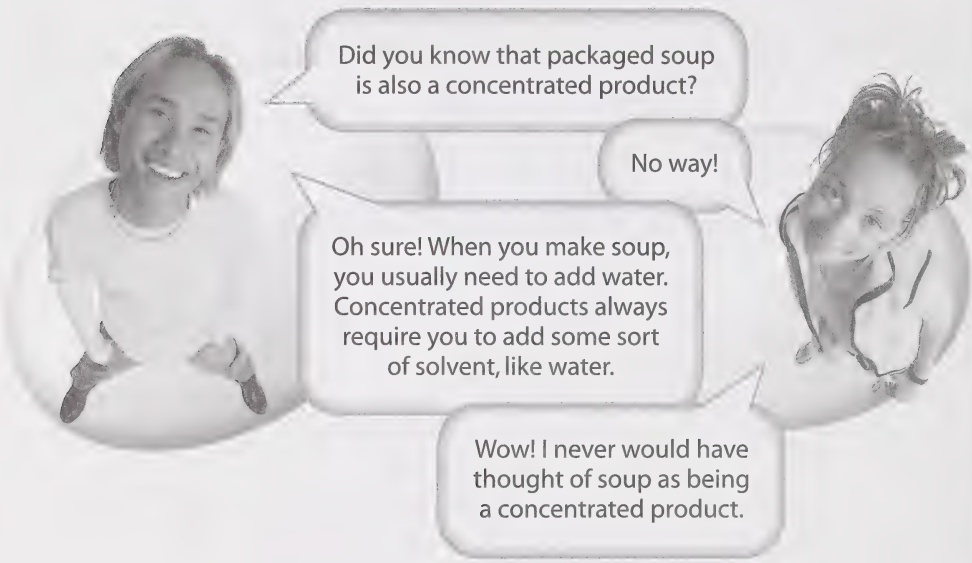
Check your answers on page 121 and 122 of the Appendix.

The Starting Point Activity on page 59 of the textbook showed that colour sometimes can be used as an approximate indicator of concentration. The activity also gave you a better understanding of the meaning of concentration. For more information on concentrated and dilute solutions, turn to page 60 of the textbook and read the introductory information of "Use Concentrated Solutions to Reduce Garbage."

13. Which has more solute per unit volume, concentrated or dilute?

14. Why are concentrated products better for the environment?

Check your answers on page 123 of the Appendix.



Many countries are heavy users of consumer products that require packaging. Packaging is used for a variety of reasons, such as protection during shipping, protection of contents from contamination or spoilage, and child-proofing the contents. Much of this packaging ends up in landfills around the globe.

Turn to page 62 of the textbook and read "Waste Packaging."

15. How many kilograms of trash does each person in Canada throw away each day?

16. What percentage of garbage in Canadian landfills is product packaging?

17. Explain how using concentrated products can reduce the volume of garbage that goes into landfills.

Check your answers on page 123 of the Appendix.

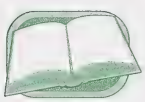
The amount of garbage produced is a key environmental issue for most countries in the world. You will revisit this issue in Module 4.

Go to pages 7 to 9 of Assignment Booklet 1B and answer questions 1 to 7.

Lesson 2

Acids and Bases

How many of the items in the photograph do you have in your home? Do you know what these items have in common? Each of these items belongs to a group of substances called acids and bases. Acids and bases are studied together because of the reaction that occurs when an acid and a base are mixed. However, acids and bases have their own distinctive properties.



Turn to page 63 of the textbook and read the introductory paragraphs of "Acids and Bases." Here you are given the definition of an **acid**, a **base**, and a **neutral substance**. Make sure you study Table 4.1 carefully.

1. Which substance is used as a preservative? Is the substance an acid or a base?

2. Which base is used in baking?

3. Give two uses for hydrochloric acid.

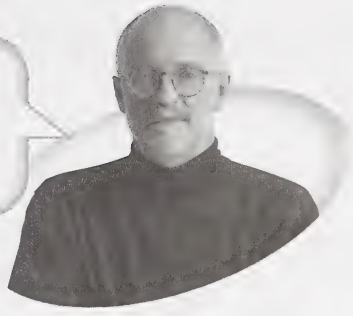
4. Which acid is used in car batteries?

5. Which substance is used to clean your hands and wash your clothes? Is it an acid or a base?

6. How does litmus paper tell you what substance is an acid and what substance is a base?

Check your answers on page 123 of the Appendix.

A number of chemical properties allow scientists to identify a substance as an acid or a base. You have already seen some of these properties in the definitions of acids and bases.



Read the first part of "Properties of Acids and Bases" on page 64 of the textbook. Table 4.2 gives you a list of properties that scientists use to identify acids and bases. Notice that some of these properties are the same or similar and some are opposite.

7. Which properties of acids and bases are similar?

8. Which properties of acids and bases are opposite?

CHECK Check your answers on page 123 of the Appendix.

Acids and bases can be identified using an indicator. An indicator is a substance that changes colour in the presence of an acid or a base. To learn about indicators, read "Identifying Acids and Bases" on page 64 of the textbook.

9. Name four substances that are indicators.

10. What is litmus? What is litmus paper?

11. Why is the hydrangea flower pink when it grows in an acid soil and blue when it grows in a basic soil?

CHECK Check your answers on page 124 of the Appendix.

In addition to being able to identify a substance as an acid or a base, it is important to be able to tell how acidic or how basic a substance actually is. Scientists have developed a scale from 0 to 14 to show how acidic or basic a substance is. Where a substance falls on this scale is called its **pH**.

Turn to page 65 of the textbook and read "A Scale for Classifying Acids and Bases." Study the pH scale in Figure 4.6, and determine where common substances are along the scale.

12. What is the pH of apples? Would you expect most fruits to be acidic or basic?

13. Which is more acidic, lemons or tomatoes?

14. What is the pH of the water in the Great Lakes? Is the water in the Great Lakes acidic or basic?

15. Is human blood acidic or basic?

Check your answers on page 124 of the Appendix.

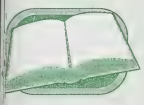
Litmus paper is used to determine if a substance is an acid or a base. Universal pH paper or a pH meter can be used to determine the pH of the substance. Universal pH paper changes colour throughout the scale from pH 0 to pH 14. It comes with a colour key on the container that you can use to match to the colour of the pH paper after you have tested a particular substance. The pH of each colour is given on the colour key.

Investigation

4-B: Acids and Bases Around You

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A



Turn to pages 66 and 67 of the textbook and read the investigation to get an overall understanding.

Note: On page 66, there is a photograph of a container of universal pH paper with a colour key on the container. This pH paper gives colours that are specific to a particular range of pH, so the colours do not conform to the standard range as shown on page 65. You will most likely use pH paper that conforms to the full range of colours in this investigation.

In this investigation you will use litmus paper to test if a substance is an acid or a base. You will then use universal pH paper to determine the pH of the substance. Collect the materials and apparatus needed, and follow the procedure on page 67 of the textbook.

Pay careful attention to the safety precautions mentioned.

16. Set up and complete a chart similar to the following. List all the substances you tested.

Substance	Prediction	Red Litmus Paper	Blue Litmus Paper	Colour Change	pH According to Scale	Acid, Base, or Neutral?
ammonia						

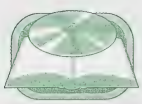
17. Answer the following on pages 67 and 68 of the textbook.

    a. questions 1 to 6 of "Analyze"

    b. questions 7 to 10 of "Conclude and Apply"

Check your answers on pages 124 to 126 of the Appendix.

Part B



Insert the *Science.Connect* 1 *Student Multimedia* CD into your computer. Launch the applet *Acids* from the Acids folder. Follow the instructions in the applet. There are six parts altogether to complete.

18. Copy and complete a table like the following. Fill in the table as you proceed through the applet. You may wish to insert a column for predicting if the substance is an acid, a base, or a neutral substance.

Substance	Red Litmus	Blue Litmus	Bromothymol Blue	Phenolphthalein	Conductivity	pH	Acid, Base, or Neutral?
distilled water							
HCl							
NaOH							

Check your answers on page 127 of the Appendix.

Now, complete question 17 from Part A of this investigation.

The previous investigation should have given you a good idea of some items around the home that are acids and some items that are bases. Acids and bases are of great importance. Some acids, such as ascorbic acid, are important to your health; other acids, such as hydrochloric acid (HCl) and sulfuric acid (H_2SO_4), are useful scrubbing agents.

In the next two activities you can test substances around the home that can be used as indicators for acids and bases.

Activity

Try This!

Turn to page 64 of the textbook and read "Try This!" in the upper left corner of the page. Collect the required materials and apparatus, and complete the activity.

19. What happened to the colour of the cranberry juice?

20. Baking soda is a base. What does the colour change suggest about the nature of cranberry juice?

CHECK

Check your answers on page 127 of the Appendix.

Now that you have some knowledge of acids and bases, try the following activity in which you make an indicator and use it to test several acids and bases in the home.

Activity

Making an Indicator

Part 1: Making a Red Cabbage Indicator

step 1: Tear or cut one or two red cabbage leaves into small pieces.

step 2: Place the pieces of the red cabbage in a beaker or a small pot with about 150 mL of water. Use distilled water if possible.

step 3: Boil the cabbage gently until most of the colour is gone from the leaves. Do not allow all the water to boil out. Remove the pot from the heat source, and allow the mixture to cool. **Be very careful not to burn yourself.**

step 4: Pour the mixture into a container through a small kitchen strainer to remove the pieces of cabbage. Discard the cabbage.

step 5: Cut strips of filter paper (or coffee filters) and place the strips so about half is soaking in the cabbage indicator. Pull the strips out and place on a small dish to dry. Keep the remaining liquid cabbage indicator to use as a liquid indicator as well.

Note: Save your cabbage juice indicator for Lesson 3.

Part 2: Using the Red Cabbage Indicator

step 1: Obtain four samples of substances around your home to test. Pick two acids (e.g., vinegar, lemon juice, tomato juice, orange juice, or black coffee) and two bases (e.g., baking soda, ammonia cleaner, or toilet bowl cleaner). Also, test tap water or distilled water.

step 2: Make a chart similar to the following to record the colour change.

Sample	Colour of Indicator Strip	Colour of Indicator

step 3: Pour about 10 mL of each sample into separate glasses.

step 4: Test each sample with the indicator strips you made. Place a drop or two of each sample on the end of the strip that was soaked in the indicator. Record the colour for each sample.

step 5: Use a teaspoon or a medicine dropper to place a few drops of the red cabbage indicator into each sample. Record the colour for each sample.

step 6: Dilute each sample with water, and flush it down the sink with even more water.

21. What observations did you make? (Insert your completed table here.)

22. Which colours of red cabbage juice indicator indicate whether a substance is acidic, basic, or neutral?

23. List the substances you tested in order from most acidic to most basic.

24. Use your results to draw and label a colour key for red cabbage indicator. Colour the scale so it matches the colour of the red cabbage indicator for the different substances and pHs.

25. Did you get the same colours for each sample with the indicator strips as with the liquid indicator?

26. List three properties of acids and three properties of bases.

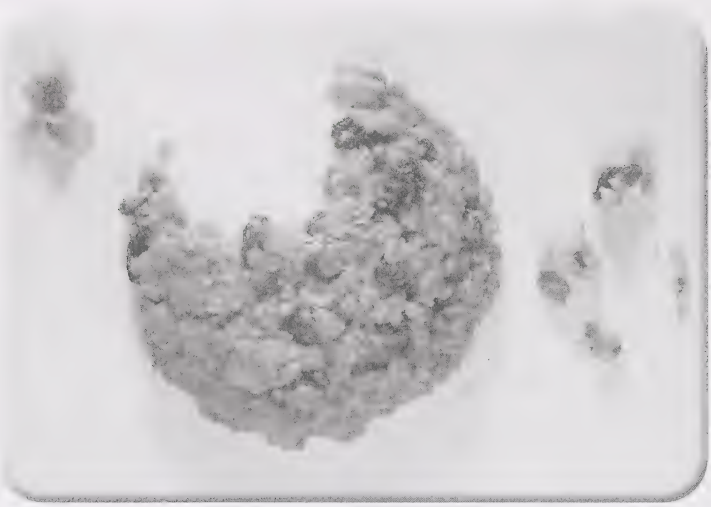
27. Use a table to list three substances that can be used as indicators. State the indicator colour in an acid and in a base for each substance.

Check your answers on pages 128 and 129 of the Appendix.

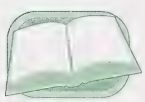
Go to pages 9 to 11 of Assignment Booklet 1B and answer questions 8 to 16.

Lesson 3

Acids and Bases in Action



Have you watched a cake or cookies rise? What makes pancakes rise as they are cooked? Many recipes call for baking powder in the recipe. Double-acting baking powder is made up of bicarbonate of soda (a base), cream of tartar (an acid), and alum (an acid). Once water (or milk) is added, a reaction takes place between the bicarbonate of soda and the cream of tartar. This results in the release of carbon dioxide bubbles that causes the mixture to rise. When the mixture is then heated, the alum reacts with the bicarbonate of soda to create more carbon dioxide bubbles.



There are many instances in which the interactions of acids and bases are involved in everyday situations. Turn to page 70 of the textbook and read the introduction to "Acids and Bases in Action."

1. Name four situations in which the interaction of acids and bases are used.

2. The chemical reaction that reduces heartburn when you take an antacid tablet is called _____.

3. Is the antacid tablet taken for heartburn an acid or a base? Explain your answer.

4. Explain why a chef may add baking soda to dried beans before cooking them.

5. Why is it dangerous to mix certain substances with acids or bases?

Check your answers on page 130 of the Appendix.

Perform the following activity to observe the results of mixing an acid (vinegar) and a base (baking soda). You will need the red cabbage indicator that you made in the previous activity.

Neutralizing an Acid with a Base

Materials and Apparatus:

- clear glass
- measuring spoons
- 10–15 mL of vinegar
- 1 mL or ($\frac{1}{4}$ teaspoon) of red cabbage indicator
- baking soda

Procedure:

step 1: Pour about 10–15 mL of vinegar into a clear glass.

step 2: Add about 1 mL ($\frac{1}{4}$ tsp) of red cabbage indicator to the vinegar. Note the colour.

step 3: Add about 0.5 mL ($\frac{1}{8}$ tsp) of baking soda. Swirl the glass gently with a circular motion. Record what you observe and the colour of the solution.

step 4: Add 0.5 mL ($\frac{1}{8}$ tsp) of baking soda and swirl again. Record the colour of the solution.

step 5: Add 0.5 mL ($\frac{1}{8}$ tsp) of baking soda and swirl. Repeat until colour changes to blue.

step 6: Discard the solution down the sink and wash the glass and spoon thoroughly.

Conclusion:

6. What colour was the solution of the vinegar and red cabbage indicator (step 2)?

7. What observations did you make in step 3? What was the colour of the solution?

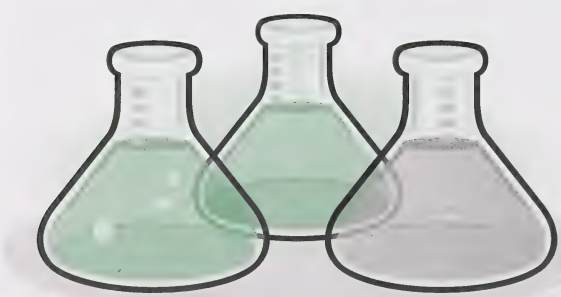
8. What was the colour of the solution in step 4?

9. What does the blue colour indicate about the make-up of the solution in step 5?

10. At what point would the solution be considered neutral?

11. What term is used to describe the reaction between the vinegar and the baking soda?

Check your answers on page 130 of the Appendix.



Both acids and bases may be extremely corrosive. Some of these substances cause severe burns to the skin or other body tissues on contact. Acids can eat through certain metals and some rocks. Corrosion is the wearing away of materials by chemical action. You are probably familiar with corrosion as rusting.

Turn to page 71 of the textbook and read "Corrosion." Pay particular attention to what affects corrosion.

12. What substance is the primary cause of rusting?

13. What two substances speed up the process of rusting?

14. What is acid rain?

15. How is acid rain formed?

16. How does acid rain affect plants?

17. What other items does acid rain affect?

18. Why do ships and objects near bodies of water corrode more quickly than objects in a dry climate?

CHECK Check your answers on pages 130 and 131 of the Appendix.

Find Out Activity

What Corrodes Steel Faster?

Remove the template for this activity on pages T3 and T4 of the Appendix (at the back of the Appendix).

Turn to page 73 of the textbook and read the entire activity. Follow the steps in "What to Do" to complete this activity.

19. Use the template to complete a lab report for this activity.

20. Answer questions 1 to 4 of "What Did You Discover?" on page 73.

CHECK Check your answers on pages 131 and 132 of the Appendix.

You may be most familiar with corrosion (rusting) of iron; but many metals corrode. Turn to page 72 of the textbook and read "Corrosion at Work." Study the information in Figure 4.13 and Figure 4.14 carefully.

21. Name the three metals mentioned that corrode, and state the colour of the corroded metal.

22. What metal is used on the parliament building in Figure 4.13? Explain your choice.

23. Why does aluminum not continue to corrode until it disintegrates?

CHECK Check your answers on pages 132 and 133 of the Appendix.

Section 4 Review

In this section you discovered the differences between a concentrated solution and a dilute solution and analyzed how using concentrated solutions can help the environment. You also identified acids and bases using indicators and defined and interpreted pH. You then investigated some factors that affect corrosion and identified some examples of corrosion in our surroundings.

You now know that the pH of shampoo is made slightly acidic so it approximately matches the pH of your hair. Washing your hair with shampoo makes it feel clean and healthy. Washing your hair with regular soap, which is slightly basic, would make it feel dry. You identified many other substances around the house that are acids or bases. The properties that make them acids and bases are what make them useful for household tasks. Remember that some of these items are strong acids or bases, so you must take precaution when using them.

You have now completed the concepts for this section. To further your understanding, do the following "Chapter 4 Review" questions on pages 74 and 75 of the textbook. If necessary, go back and read over parts of this section as you answer the questions.

1. Answer question 2 of "Review Key Terms."

2. Answer questions 10, 12, and 14 of "Understanding Key Ideas."

3. Answer question 17 of "Developing Skills."

4. Answer questions 19 and 22 of "Problem Solving/Applying."

CHECK

Check your answers on page 132 of the Appendix.

Go to ...

Go to pages 11 to 13 of Assignment Booklet 1B and answer questions 17 to 25.

Module Summary

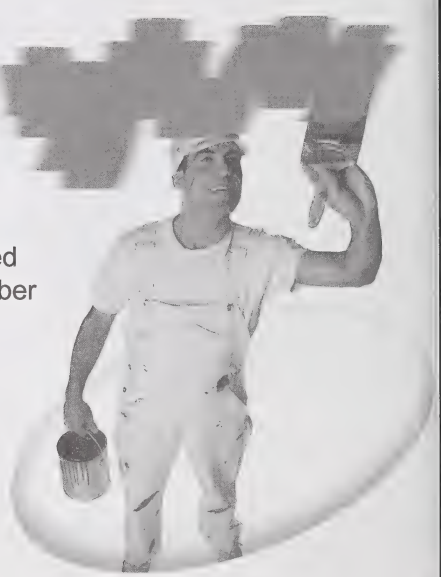
In this module you investigated the properties of matter.

In Section 1 you identified the need for safety with chemicals at home, in the school, and in the workplace. You identified the three states of matter, defined chemical and physical properties of matter, and classified matter as pure substances or mixtures.

In Section 2 you discovered how elements are organized in the periodic table and described the relationship between elements and compounds. You then discovered how chemicals are named and learned to interpret chemical formulas.

In Section 3 you determined the differences between solutions and mechanical mixtures and identified the solute and solvent in a solution.

In Section 4 you were able to communicate the concentration of a solution and describe how temperature affects solubility. You compared concentrated and dilute solutions and assessed how using concentrated solutions can help the environment. You discovered how to identify acids and bases using an indicator and learned how to interpret pH. You also analyzed a number of factors that affect corrosion.



You performed a number of activities and investigations relating to solutions and mixtures and discovered that many chemicals are both useful and dangerous. You learned that chemicals can pose special hazards and that people who work with hazardous chemicals must take training to identify these hazards and what safety precautions must be taken.

APPENDIX

GLOSSARY ■ SUGGESTED ANSWERS ■ IMAGE CREDITS

Glossary

acid: a corrosive, sour-tasting substance that turns blue litmus paper red

base: a slippery, bitter-tasting substance that turns red litmus paper blue

chemical formula: letters and numbers written together to represent the make-up of a compound

chemical property: a property that describes how a substance will react with other substances

compound: a substance that is made up of two or more elements that have been chemically combined

concentrated: having a large amount of solute per volume of solvent

concentration: the amount of solute in a given amount of solution

corrosion: the breakdown of a substance by chemical action

decomposition reaction: a process through which compounds are broken down into the simpler substances that make up the compound

dilute: having a small amount of solute per volume of solvent

distillation: a process by which one component is separated from a solution by evaporation and then collected

element: a substance that contains only one type of atom and cannot be chemically broken down any further

gas: a state of matter in which the particles are loosely packed and move about freely

indicator: a substance that changes colour in the presence of an acid or a base

liquid: a state of matter in which the particles are close together but able to slide over one another

litmus: an indicator that is made from lichen

litmus paper: a strip of filter paper that has been soaked with litmus

matter: anything that has mass and occupies space

mechanical mixture: a mixture in which you can see the different type of particles

neutral substance: a substance that does not have the properties of either an acid or a base

physical property: a property that describes the appearance, texture, odour, or temperature of a substance

pH: a number that indicates how acidic or basic a substance is

pH scale: a scale that classifies a substance according to how acidic or basic it is

solid: a state of matter in which the particles are packed closely together and move very little

solubility: the ease with which a substance will dissolve

solute: a substance that is dissolved in a solution

solution: a uniform mixture of two or more substances

solvent: a substance in which other substances dissolved in a solution

theory: an explanation of something that can be supported by experimental results

Suggested Answers

Section 1: Lesson 1

1. Answers will vary. Examples of substances that contain chemicals you may have used recently are toothpaste, shampoo, mouthwash, sink cleaner, water, soap, bread, and milk.

2. No, the word *chemical* does not apply only to substances that are used to kill insects or weeds. Actually, any substance you use, the food you eat, or clothing you wear is made up of chemicals.

3. Answers will vary. You can give examples that are not listed in the chart. Some household materials that are dangerous when ingested or in contact with your skin are bleach, oven cleaner, toilet cleaner, ammonia cleaner, nail polish, fuel oil, paint, and paint thinner.

4. **Textbook questions 1 and 2 of "What Did You Discover?," p. 5**

    1. The calcium chloride and sodium bicarbonate were both white powders; the indicator was a red liquid.

    2. a. When the materials mixed together, there was a colour change. The mixture bubbled. Also, the bag expanded slightly and felt warmer.

       b. The mixture in the bag at the end of the procedure was yellow.

5. If large amounts of each substance were used, the temperature change would have been significantly greater. The amount of gas produced would also have been greater.

6. The materials need to be disposed of in a safe manner. Many chemicals used in a high school lab may be safely washed down the drain. Chemicals that cannot be safely flushed down the drain should be collected by your lab teacher and picked up by an authorized disposal company.

7. Answers will vary. If you live in an urban area or town, some of the substances that require special storage or disposal are medicines, bleach, ammonia, lye, gasoline, camping fuel, paint thinner, and insecticides. If you live on a farm or acreage, you may have additional substances that require special storage or disposal. These may include weed sprays, stronger insecticides, animal vaccines, and special cleaning solvents.

8. Products, like paint cans and insecticide containers, that require special disposal can be taken to a special collection site in a designated area of your local landfill or sometimes firehall. Cities may have a particular time of the year to bring in containers requiring special disposal to a particular site. Out-of-date medicines can be taken to most pharmacies for disposal.

9. The three elements of WHMIS are WHMIS labels, Materials Safety Data Sheets (MSDSs), and education.

10. a. Oxidizing materials may cause a fire or explosion if near flammable or combustible materials. Also, it may burn skin and eyes upon contact. Examples are bromine and hydrogen peroxide.

    b. Substances that have immediate and serious toxic effects may be fatal if swallowed, inhaled, or absorbed through the skin. They may also burn skin or eyes upon contact. Examples are methanol and sulfuric acid.

11. You may have listed workers in many occupations. Workers who need WHMIS training include warehouse workers, drywall workers, painters, horticulturists, welders, potters, decorators, cleaners, and farmers.

12. Three ways in which information is provided through the WHMIS system are by labels, Materials Data Safety Sheets (MSDSs), and worker education. Labels summarize safe handling procedures for chemicals. Materials Data Safety Sheets provide detailed information about each chemical. It includes physical properties, safe handling, first aid, and disposal procedures. Worker education provides training for all employees who must handle dangerous chemicals.

13. Toluene is flammable and will have long-term toxic effects from repeated exposure.

14. a. The chemical is calcium chloride anhydrous (or simply calcium chloride).

    b. This substance should be stored in a tightly closed container in a cool, dry, well-ventilated area. Keep it away from flame and sparks. Exposure to atmosphere allows calcium chloride to absorb water and form a solution.

    c. This product is not considered to be a fire or explosion hazard.

d. The area of a spill must be ventilated. Spills are to be swept up and put in a container for reclamation or disposal. Use vacuuming or wet sweeping to avoid dust dispersal. Small amounts of residue may be flushed to sewer with plenty of water. Avoid inhalation, ingestion, and contact with eyes or skin.

e. Acute exposure causes moderate irritation to skin, eyes, and the respiratory tract. Chronic (long-term) exposure may produce "soda ulcers" on hands and perforation of the nasal system.

f. If the substance contacts the eye, immediately wash eyes with plenty of water for at least 15 minutes, lifting upper and lower eyelid occasionally. Seek medical attention.

   If the substance contacts skin, wipe off excess material and wash with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes. Seek medical attention if irritation occurs or persists.

   If the substance is inhaled, take the individual out for fresh air. If the individual is not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical attention.

   If the substance is ingested, give large quantities of water to dilute it. Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Seek medical attention.

15. **Textbook questions 1, 2, and 3 of "What Did You Find Out?," p. 8**

    1. If using this product, provide adequate ventilation and access to water and shower. Make sure you wear appropriate protective equipment, such as goggles and a lab coat.

    2. The MSDS provides more information than the label.

    3. All safety information is not provided on the label because there is not enough room.

16. The substance with the triangular corrosive symbol is only slightly corrosive and can cause some skin irritation if contacted. The substance with the octagonal corrosive symbol is extremely corrosive and can cause severe burns to the skin if contacted.

17. Many home products have safety labels. The label should have pertinent safety, first-aid, and disposal information. Samples of products with HHPS labels include toilet bowl cleaners, wall and tile cleaners, oven cleaners, bleaches, detergents, and those in aerosol containers.

18. **Textbook questions 1 to 4 of "Check Your Understanding," p. 9**

1. Many useful chemicals are dangerous. For example, a flammable liquid, like gasoline, is very dangerous if not handled properly; but gasoline provides the energy for much of your everyday transportation. Other chemicals, such as insecticides and herbicides, are useful because they are poisonous to insects and unwanted plants. This means they can also be harmful to other living organisms, including humans.

2.

WHMIS and HHPS		
Similarities	• provide safety and first-aid information • use symbols that are easy to understand • found on chemicals	
	WHMIS	HHPS
Differences	• found on chemicals in the workplace • required in all workplaces that use chemicals • includes training system, labels, and MSDS • specific symbol for a particular hazard	• found on consumer products used in the home • shape of symbol border designed to match the shape of traffic signs • shape and colour of border of symbol communicates level of danger • manufacturers not required to use the symbols

3. Examples of hazardous chemicals around the home are general household cleaners, oven cleaner, bleach, toilet cleaner, insecticide, pesticide, paint, paint thinner, and gasoline.

4. a. Flammable products should be stored in a cool, dry place away from sources of sparks or heat. Also, it is preferred that they are stored away from the living area.

   b. More information about the handling and storage of hazardous workplace substances can be found on Material Safety Data Sheets (MSDSs). The MSDS for a particular substance can often be ordered from the manufacturer. The MSDS can also be found on the Internet, at sites such as

   http://msds.pdc.cornell.edu/msdssrch.asp

Section 1: Lesson 2

1. Scientists describe matter as anything that has mass and takes up space.

2. All of the suggested items are made up of matter.

3. The particle theory states that the distance between the particles is different for solids, liquids, and gases.

4. A gas would have the greatest distance between particles. One reason why you might have predicted this is because if you think of air (a mixture of gases), you can see through it. This would suggest the particles are far apart.

5. You have most likely seen water in its three states: as a solid (ice), as a liquid, and as a gas (steam).

6. A solid keeps its shape because the particles are packed tightly together and cannot move very much. They can only vibrate.

7. A liquid takes the shape of its container because the particles that make up the liquid can move and slide over each other in this state.

8. The container holding the gas has a lid because the particles of the gas would escape and spread further apart if the container was left open.

9. a. The cornstarch thickens and forms a semi-solid under your finger.

   b. The cornstarch behaves as a solid when you push your finger into it slowly; it holds its shape.

   c. This mixture does not really fit the definition of either a solid or a liquid.

10. a. Answers will vary. A sample answer is given.

Appearance	Behaviour
blond hair brown eyes about 5 feet 8 inches (170 cm) tall	often smiles at others often helps others speaks confidently

   b. The things about the person's appearance, such as hair colour, eye colour, and height, is similar to the physical properties of a substance.

c. The things about the person's behaviour, such as smiling at others, helping others, and speaking confidently, is similar to the chemical properties of a substance.

11. Physical properties of a substance consists of how it looks or feels. Chemical properties of a substance explains what happens when the substance is mixed or put in contact with other substances.

12. Your completed chart should be similar to the following.

Type of Test Material	Conductivity Result	Is the Material Magnetic?	Does the Material Scratch Easily?	Colour	Texture
loonie	yes	yes	no	bronze	smooth
penny	yes	no	no	brown	smooth
rubber washer	no	no	yes	black	tacky
plastic spoon	no	no	yes	white	smooth
pen	no	no	yes	clear	smooth
cloth	no	no	yes	varies	various textures
metal washer	yes	yes	no	silver	smooth
metal spoon	yes	yes	no	silver	smooth
pencil	no	no	yes	varies	smooth
paper	no	no	yes	varies	smooth

13. You could group the items according to the results under any particular heading. The loonie, penny, metal washer, and metal spoon are in one group based on similar conductivity, ease of scratching, and texture. However, the penny would not fit in this group when magnetic effect is considered.

    The plastic spoon, pen, pencil, and paper could be grouped together based on ease of scratching and texture.

    The rubber washer and the cloth don't seem to fit into either group due to texture.

14. **Textbook questions 1 to 4 of "Evaluate," p. 15**

1. Yes, most of the substances could be classified using a number of criteria, such as conductivity, magnetic effect, hardness, colour, and texture.

2. Yes, although some criteria were the same for a number of items, other criteria made some items in the group distinguishable.

3. A number of substances had the same conductivity and hardness. These substances differed in colour.

4. The classification system could be improved by having more criteria or tests.

15. **Textbook questions 1 and 4 of "Check Your Understanding," p. 15**

1. The particles in a liquid are able to slide over one another; therefore, the particles move enough so the liquid takes the shape of a container. The particles in a gas are able to move freely; therefore, the gas takes the shape of the container. The particles in a solid cannot move over one another; therefore, the solid keeps its shape.

4.

Physical Property	Chemical Property
thick fluid blue in colour lighter than air odourless colourless	dissolves fats corrosive to skin explodes when spark is present

Section 1: Lesson 3

1. A mixture contains more than one type of particle. A pure substance contains only one type of particle.

2. No, "pure orange juice" is not a pure substance. It is composed of water as well as various other substances that are part of the orange that is squeezed to make the orange juice.

3. Some examples of pure substances are distilled water, baking soda, sugar, salt, mercury, and aluminum.

   Some examples of mixtures are concrete, milk, toothpaste, maple syrup, perfume, salad dressing, peanut butter, and cat food.

4. Physical properties you might use are smell, texture, and density. Chemical properties you might use are freezing (melting) and boiling points.

5. **Textbook questions 1 and 2 of "Prediction," p. 18**

    1. Predictions may vary. You may have predicted Beaker A or Beaker D to have the lowest melting point.

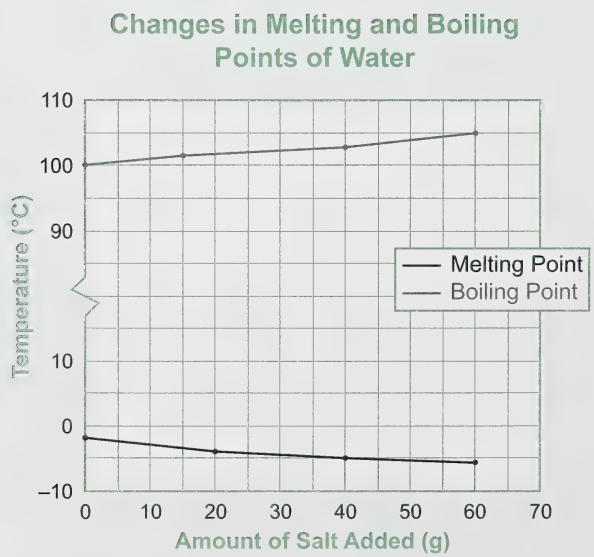
    2. Predictions may vary. You may have predicted Beaker A or Beaker D to have the highest boiling point.

6. Results will vary. Sample results are given.

Beaker	Melting Point	Boiling Point
A (0 g salt)	– 2°C	100°C
B (20 g salt)	– 4°C	102°C
C (40 g salt)	– 5°C	103°C
D (60 g salt)	– 6°C	105°C

Note: Boiling points here are for sea level. The boiling point of water in and around Edmonton is about 97°C or 98°C.

7. Your graph should look like the following. Make sure your graph is accurate to your results.



8. **Textbook questions 1, 2, and 4 of "Analyze," p. 19**

   1. a. Beaker D reached the lowest temperature.

      b. Yes, there was some liquid in that beaker.

   2. Answers will vary. A sample answer is given.

      The boiling point of mixture A was 100°C. The boiling point of mixture B was 102°C. The boiling point of mixture C was 103°C. The boiling point of mixture D was 105°C.

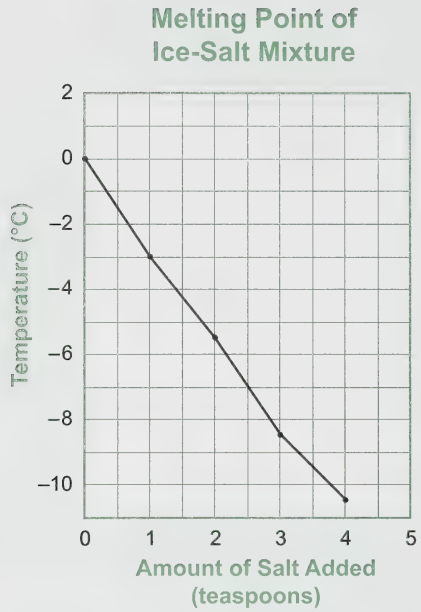
   4. As salt is added, the graph shows a steady increase in the boiling points and a steady decrease in the melting points.

9. Your completed chart should be similar to the following.

Number of Teaspoons of Salt Added	Measured Melting Point	Adjusted Melting Point
0	1.5°C	0°C
1	– 1.5°C	– 3.0°C
2	– 4.0°C	– 5.5°C
3	– 7.0°C	– 8.5°C
4	– 9.0°C	– 10.5°C

10. You may not have obtained a temperature of 0°C because the thermometer you are using may not be accurate to within 0.5°C.

11. Your graph should be similar to the following.



12. The temperature of the mixture decreases as more salt is added.

13. After 0.5 h, the salt (sodium chloride) was still on top of the ice cube and the de-icer (calcium chloride) had melted into the ice cube.

14. This activity shows that calcium chloride can melt ice even in a freezer, whereas sodium chloride cannot.

Section 1 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 20**

    1. a. A physical property of a substance is one that you can see, feel, or smell. A chemical property of a substance is one that you can observe the reactions of a substance with other substances.

    b. Matter is anything that has mass and occupies space. Particles are the smallest bits to which a substance can be chemically broken down. Matter is made up of particles.

    c. A pure substance is made up of only one type of particle. A mixture is made up of more than one type of particle.

2. **Textbook questions 3, 4, and 8 of "Understanding Key Ideas," p. 20**

3. Things to consider include the following:

   - Are any of the chemicals flammable and require an area that is protected from extreme temperature, flame, or spark?
   - Are the vapours of any of the chemicals harmful and need a location that has proper ventilation?
   - Are any of the chemicals very corrosive?
   - Are some chemicals extremely reactive with other chemicals and, therefore, require a separate storage area?

4. The physical properties that make a golf ball different from a tennis ball could include the following:

   - mass
   - size
   - colour
   - texture
   - hardness

8. a. physical change b. chemical change

   c. physical change d. chemical change

   e. physical change f. chemical change

3. **Textbook question 17 of "Critical Thinking," p. 21**

17. As the temperature drops, the particles in a liquid move slower and the spaces between the particles get smaller.

> **Note:** Once the temperature of water goes below 4°C, the spaces between the water particles actually get larger until the freezing point is reached. This is why ice expands.

Section 2: Lesson 1

1. Dmitri Mendeleev wrote all the properties for each known element on a separate file card. He then put all file cards with similar properties together and called them a group.

2. Mendeleev organized the elements from lightest to heaviest within each group.

3. Mendeleev organized the groups of elements into a table so that the groups with the lightest elements were on the left side and the groups with the heaviest elements were on the right side.

4. Water is made up of hydrogen and oxygen atoms.

5. a. There are 18 groups in the periodic table on page 25 of the textbook.

   b. There are 6 periods in the periodic table on page 25 of the textbook.

6. All periodic tables look like a chart. Each square represents one element and contains information about that element.

7. Each square in this periodic table contains the name of the element and shows whether the element is a metal, non-metal, or metalloid. The expanded squares also show the element number; the symbol for the element; whether the element is a solid, liquid, or gas at room temperature and normal air pressure. The large expanded square for hydrogen also shows the element's mass. Periodic tables vary in what information is included in the square.

8. There are eight elements in Period 2.

9. The properties of metals are as follows:

   - bright or shiny
   - easily shaped or malleable
   - solid at room temperature (except for mercury)
   - generally good conductors of heat and electricity

   The properties of non-metals are as follows:

   - dull
   - brittle
   - solid or gas at room temperature
   - poor conductors of heat and electricity

10. The white squares along the staircase line in the periodic table on page 25 represent elements that have some properties of metals and some properties of non-metals. These elements are called metalloids.

11.

Element Name	Symbol	Period	Group	Metal or Non-Metal
chromium	Cr	4	6	metal
bromine	Br	4	17	non-metal
phosphorus	P	3	15	non-metal
helium	He	1	18	non-metal
bohrium	Bh	7	7	metal
bismuth	Bi	6	15	metal
carbon	C	2	14	non-metal
tin	Sn	5	14	metal
chlorine	Cl	3	17	non-metal
niobium	Nb	5	5	metal

12. **Textbook questions 1 to 4 of "Analyze," p. 28**

    1. Answers may vary. It was probably easier to complete the table when the period and group numbers were given.

    2. All the elements that were classified as metals are on the left side of the staircase line.

    3. When only the period and group numbers were given, you used the chart like a graph and went along the required row until you came to group number. The intersection of the row and the column is the required element.

    4. You may have noticed that the mass of the elements increases as you move to the right (increasing group numbers) and down (increasing period number).

13. The safety precautions should include information on handling the various samples as well as general laboratory safety.

14. **Textbook questions 1 to 7 of "Plan and Construct," p. 29**

1.

Properties of Metals	Properties of Non-Metals
• bright, metallic shine • easily shaped (malleable) • solid (except for mercury) • good conductors of heat and electricity	• dull, various colours • brittle • solid or gas (except bromine) • poor conductors of heat and electricity

2. Try bending the item with your hands.

3. Use a conductivity tester or multi-meter by placing the sample between the two ends of the conductivity tester or multi-meter. If the light on the conductivity tester lights up or if the needle on the multi-meter moves sharply, the substance conducts electricity well.

4. You can use the steel wool to clean the surface of the substance you want to check for conductivity. **Caution:** Avoid cleaning the lead sample with steel wool. The steel wool might also be used to make a sample shinier.

5. Other materials or apparatus you might need are rubber gloves and a watch glass or dish to place the items on.

6. **Conductivity Test**

step 1: Put on rubber gloves, and clean each sample (as required) with steel wool.
step 2: Place the sample on a watch glass or dish.
step 3: Touch the ends of the conductivity tester or the probes of the multi-meter to the surface of the sample to be tested.
step 4: Check if the light comes on or if the needle moves. Record your results.
step 5: Repeat steps 1 to 4 for each sample.

Ease of Bending Test

step 1: Put on rubber gloves.
step 2: Pick up each sample in turn, and try to bend it.
step 3: Record your results.
step 4: Repeat steps 1 to 3 for each sample.

Colour or Lustre

step 1: Put on rubber gloves, and clean each sample (if necessary).
step 2: Inspect each sample, and record your results.
step 3: Repeat steps 1 and 2 for each sample.

7. a. Your observations should be in a chart similar to the following. Your table may not include all the substances in this table. Depending on the shapes of your samples, you may not be able to bend some of the metals.

Sample	Prediction	Colour	Lustre	Bendable	Conducts Electricity	Conclusion
copper	metal	orange-brown	shiny	yes	yes	metal
sulfur	non-metal	yellow	dull	no	no	non-metal
carbon	non-metal	black	dull	no	yes	non-metal
iron	metal	grey	shiny	yes	yes	metal
magnesium	metal	silver	shiny	yes	yes	metal
nitrogen	non-metal	white	dull	no	no	non-metal
lead	metal	grey	shiny when scratched	yes	yes	metal
zinc	metal	silver-grey	shiny	yes	yes	metal

b. Your prediction should be in the chart.

15. a. **Textbook questions 2, 3, and 4 of "Evaluate," p. 29**

2. You should have been able to classify most of the samples.

3. a. Metals have the following properties:

- shiny
- bendable
- conduct electricity

b. Non-metals have the following properties:

- dull
- not bendable without breaking
- do not conduct electricity (except carbon)

4. The results from the lustre and ease of bending tests could have been misleading. Metals can lose their lustre due to exposure to air. Also, many non-metals, such as plastics, are easily bendable. Depending on the shape of the sample, a metal might not be easily bent by hand. The conductivity test can be misleading, too. For example, carbon is a non-metal that does conduct electricity. Nitrogen is not easily tested.

b. **Textbook question 5 of "Extend Your Skills," p. 29**

5. The tests would most likely reveal that the sample is a metal. The fact that the material is heavy suggests a metal. Polishing or scratching the surface may reveal a shiny material beneath.

16. The substances tested were copper and sulfur.

17. The tests used were a test for lustre, conductivity, and ease of bending.

18. Answers may vary. Your procedures should include the following:

Colour or Lustre Test

step 1: Put on rubber gloves, and clean each sample (if necessary).
step 2: Inspect each sample to see if it is dull or shiny.
step 3: Record the results.
step 4: Repeat steps 1 to 3 for each sample.

Conductivity Test

step 1: Put on rubber gloves, and clean each sample with steel wool (except lead).
step 2: Place the sample on a watch glass or dish.
step 3: Touch the ends of the conductivity tester or the probes of the multi-meter to the surface of the sample to be tested.
step 4: Check if the light comes on or if the needle moves, and record your results.
step 5: Repeat steps 1 to 4 for each sample.

Ease of Bending Test

step 1: Put on rubber gloves.
step 2: Pick up each sample in turn, and try to bend it.
step 3: Record the results.
step 4: Repeat steps 1 to 3 for each sample.

19. The following safety precautions were followed:

    - the use of gloves to handle the substances
    - the use of eye and clothing protection
    - maintain a clean work area

20. Three properties of a metal are as follows:

    - shiny
    - bendable
    - conducts electricity

    Three properties of a non-metal are as follows:

    - dull
    - brittle
    - does not conduct electricity

21. The clue that has been used is the grouping of metals and non-metals in the periodic table.

22. **Textbook question 2 of "Check Your Understanding," p. 30**

    2. a. non-metal b. metal c. metal d. non-metal e. metal

Section 2: Lesson 2

1. An element is a substance that cannot be chemically broken down into simpler substances.

2. A compound is a substance made up of two or more elements chemically combined together.

3. An element consists of one kind of atom. It is a pure substance. A compound consists of two or more kinds of atoms joined chemically to create a new pure substance.

4. You might predict that gases are formed when an electric current is passed through water and that different gases are collected in each of the test tubes. You may already know that water is made up of hydrogen and oxygen and predict that the gases collected in the test tubes are hydrogen and oxygen.

5. You probably know that hydrogen is explosive and that oxygen supports combustion. As a result, you need to be cautious when performing this investigation even though the amounts of hydrogen and oxygen produced are small. Also, since you are handling chemicals, you need to wear rubber gloves and wash your hands when you have completed the investigation.

6. a. **Textbook questions 1, 2, and 3 of "Analyze," p. 33**

1. **Test for hydrogen:** Light a splint and bring the splint near the mouth of the test tube. Listen for a "pop," and check to see if the flame has been blown out.

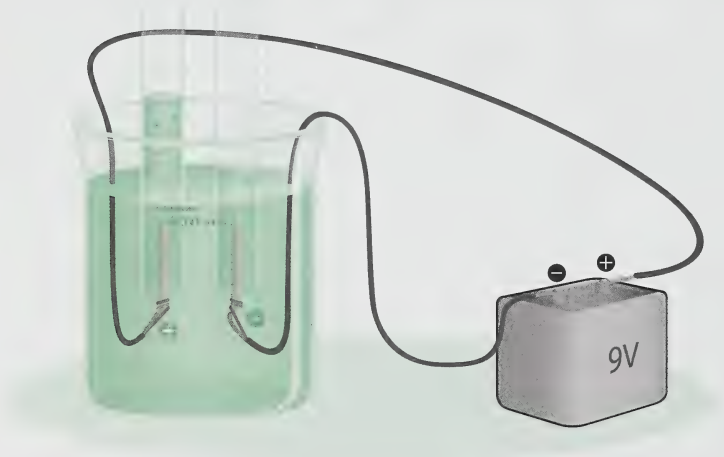
   Test for oxygen: Light a splint, then blow out the flame and place the glowing end of the splint in the test tube. Watch for an increase in the glow of the splint or see the flame re-appear on the splint.

2. The gases present in the tubes are hydrogen and oxygen. The flame test and glowing splint test described in question 1 shows that hydrogen and oxygen are present.

3. Water is a compound, since two separate substances (hydrogen and oxygen) were obtained from water by passing an electric current through it.

b. **Textbook questions 4 and 5 of "Conclude and Apply," p. 33**

4.



   a. The test tube with the larger amount of gas contains the hydrogen and the other test tube contains the oxygen.

   b. Yes, since the chemical formula of water shows that there are two atoms of hydrogen for each atom of oxygen, there will be twice as much hydrogen as oxygen in the test tubes.

5. If you switched the wires on the battery terminals, you would get oxygen gas in the test tube that had the hydrogen gas and hydrogen gas in the test tube that had oxygen gas.

7. **Textbook questions 1 and 4 of "Check Your Understanding," p. 34**

   1. An element cannot be chemically broken down into simpler substances. It is composed of a single kind of atom. Compounds are composed of two or more different kinds of atoms that have been chemically combined.

   4. Answers will vary but could include the following:

      - natural gas for heating
      - water for drinking and cooking
      - copper in water pipes
      - salt for seasoning
      - silver for jewellery and utensils

Section 2: Lesson 3

1. No, the name or spelling of the name for hydrogen is not the same in all the languages listed in Table 2.2.

2. Yes, the symbol for hydrogen is the same in all the languages listed in Table 2.2.

3. Although the name for the chemical elements may not be the same in all languages, the symbols for the chemical elements are the same in all languages.

4. The symbols for carbon and nitrogen are the first letter of their English names.

5. The symbol "C" is not used for calcium because it was already used for carbon. The symbol for calcium is the first and second letters of its English name.

6. Lead is one of the elements that was known in ancient times. The symbol "Pb" comes from the letters of the Latin name for lead, plumbum.

7. H – symbol for hydrogen

   2 – means there are two atoms of hydrogen

   O – symbol for oxygen

   2 – means there are two atoms of oxygen

   ℓ – means the chemical is a liquid at room temperature

8. The difference is that there are two atoms of oxygen in hydrogen peroxide and only one atom of oxygen in water.

9. There are four atoms in the formula for hydrogen peroxide and three atoms in the formula for water.

10. a. Letters tell you which element or elements are present in the substance.

    b. Subscript numbers tell you how many atoms of each element are in the formula (or the proportion of one element to another element in a substance).

    c. Subscript letters tell you the state of the substance at room temperature.

11. Your completed chart should be similar to the following.

Compound Name	Common Use	Chemical Formula	Number and Name of Elements	Total Number of Atoms
calcium carbonate	chalkboard chalk	$CaCO_{3(s)}$	3 elements, calcium, carbon, oxygen	5
sodium phosphate	heavy-duty cleaner	$Na_3PO_{4(s)}$	3 elements, sodium, phosphorus, oxygen	8
magnesium chloride	de-icing roads	$MgCl_{2(s)}$	2 elements, magnesium, chlorine	3
monosodium glutamate (MSG)	food seasoning	$NaC_5H_8NO_{4(s)}$	5 elements, sodium, carbon, hydrogen, nitrogen, oxygen	19
hydrogen peroxide	bleach and disinfectant	$H_2O_{2(\ell)}$	2 elements, hydrogen, oxygen	4
glucose	sugar	$C_6H_{12}O_{6(s)}$	3 elements, carbon, hydrogen, oxygen	24
carbon dioxide	fizz in pop, dry ice	$CO_{2(g)}$	2 elements, carbon, oxygen	3
freon-12	refrigerator coolant	$CCl_2F_{2(g)}$	3 elements, carbon, chlorine, fluorine	5

12. **Textbook questions 1 and 2 of "What Did You Find Out?," p. 37**

1. a. The subscript numbers in the chemical formula tell you how many atoms of each element are in the formula or the proportion of the elements in the substance.

   b. If there is no subscript number, it is understood that there is 1 atom of that element.

2. $21+22+2+2=47$

   There are 47 atoms represented by the formula for strychnine.

13. **Textbook questions 1 and 3 of "Check Your Understanding," p. 37**

1.

Element Symbol	Element Name
Na	sodium
Zn	zinc
Cu	copper
N	nitrogen

3. The element should be a non-metal because it is dull, brittle, and crumbly.

Section 2 Review

1. **Textbook questions 1 and 3 of "Reviewing Key Terms," p. 38**

1. a. iv b. iii c. ix d. vi e. i f. v

   g. xi h. x i. vii j. ii k. viii

3. A chemical formula is used to identify a compound.

2. **Textbook question 5 of "Understanding Key Ideas," p. 38**

5.

Element Name	Symbol	Period	Group
cadmium	Cd	5	12
zirconium	Zr	5	4
potassium	K	4	1
hyrodgen	H	1	1
oxygen	O	2	16
niobium	Nb	5	5

3. **Textbook question 8 of "Developing Skills," p. 38**

8. a. If the element is left of the staircase line, it is a metal. If the element is right of the staircase line, it is a non-metal.

   b. There are 87 metals and 17 non-metals. There are about five times as many metals as non-metals.

4. **Textbook questions 10 and 14 of "Problem Solving/Applying," p. 39**

10. a. gold b. tungsten c. steel

    d. helium e. carbon dioxide f. nylon

    g. aluminum

14. You can recommend that the crate be allowed to enter the country. According to the chemical formulas, the substances are sodium bicarbonate, calcium carbonate, and sodium chloride. These substances are all non-hazardous.

Section 3: Lesson 1

1. The three categories of water mentioned were safe water, clear water, and dirty water.

2. You might be able to separate pieces of wood, sand, gravel, and bugs using a paper or cloth filter.

3. Reports will vary slightly. A sample report is given.

   Title: Separating a Mechanical Mixture

   Problem: Which substances can be separated from a mechanical mixture?

   Materials and Apparatus: The materials and apparatus are listed under "What You Need" on page 41 of the textbook.

   Procedure: The procedure is given in "What to Do" on page 41 of the textbook.

   Observations: The iron filings were attracted to the magnet and removed from the dry mixture. The filter paper removed the sand from the mixture of water, sand, and sugar.

   Conclusion: The substances that could be separated from the mixture by filtering are the ones that can be seen as separate substances (e.g., the iron filings and the sand).

4. The two kinds of mixtures are mechanical mixtures and solutions.

5. If you can see the different substances that make up the mixture, you are looking at a mechanical mixture.

6. The substances that made up the first mechanical mixture in the activity were sand, sugar, and iron filings. The substances that made up the second mechanical mixture were sand and a sugar-water solution (and any remaining iron filings).

7. Answers will vary. Examples of mechanical mixtures around the home include cake mixes, spice mixes, pancake mixes, orange juice, jars of pickles, and cans of mixed nuts.

8. You can see only one substance after the sugar and water are mixed thoroughly.

9. No, a residue does not appear on the filter paper or cloth.

10. The crystals of sugar have dissolved to particles of sugar that are small enough to pass through the filter paper or cloth.

11. The sugar is the solute, and the water is the solvent.

12. A *solute* is a substance that dissolves when making a solution.

    A *solvent* is a substance the solute dissolves in.

13. In a solution, there is usually more solvent present than solute.

14. No, a solution does not always have to be colourless. Examples of solutions that are not colourless are Kool-Aid®, glass cleaner, pop, shampoo, liquid dishwashing detergent, coffee, and tea.

15. Your table will only consist of four mixtures.

Mixture	Prediction (mechanical mixture or solution?)	Observations Before Filtering	Observations After Filtering	
			In Filter	In Beaker
tea (liquid)	solution	mixture has no visible particles	no residue or particles	mixture looks same as original
sugar and water	solution	mixture is clear and has no visible particles	no residue or particles	mixture looks same as original
clear apple juice	solution	mixture has no visible particles	no residue or particles	mixture looks same as original
orange juice	mechanical mixture	mixture has particles of orange pulp	particles of orange pulp present on filter	mixture lacks particles of orange pulp
sand and water	mechanical mixture	mixture has particles of sand in water	particles of sand and dirt present on filter	mixture lacks particles of sand or dirt
coffee with grounds	mechanical mixture	mixture has visible coffee grounds present	coffee grounds present on filter	mixture lacks coffee grounds

milk	solution	mixture is white and has no visible particles	no residue or particles	mixture looks same as original
soda pop (cola)	solution	mixture is black and has no visible particles	no residue or particles	mixture looks same as original

16. **Textbook questions 1 and 2 of "What Did You Find Out?," p. 44**

    1. Answers will vary. Some or all of your observations may have matched your predictions. See the predictions column in the table in the answer to question 15.

    2. A mixture is a solution if no particles can be seen in it or if no residue or particles are visible on the filter. A mixture is a mechanical mixture if particles can be seen in it or if particles can be filtered out.

17. **Textbook questions 1.a., 1.b., 1.c., 2, 3.a., and 3.c. of "Check Your Understanding," p. 44**

    1. a. mechanical mixture

       b. solution

       c. solution

    2. Two tests to see if a mixture is a solution or a mechanical mixture are as follows:

       - Observe the mixture. If more than one type of particle can be seen, it is a mechanical mixture.

       - Put the mixture through a filter. If part of the mixture remains on the filter, the mixture is a mechanical mixture.

    3. a. Salt is the solute, and water is the solvent.

       c. Oxygen and other gases are the solute, and nitrogen is the solvent.

Section 3: Lesson 2

1. Concentration is defined as a ratio representing the amount of solute present in a stated amount of a solution.

2. The manufacturer of Roundup™ shows concentration in grams per litre (g/L).

3. The concentration on the Roundup™ label tells you there are 7 g of glyphosate in 1 L of Roundup™.

4. The purpose of the activity is to examine the concentrations of solutes in of a variety of consumer products by examining their product labels.

5. Your completed table should be similar to the following.

Commercial Name	Solute	Solvent	Concentration
Canada Dry®	sugar	carbonated water	9.8 g/100 mL
Javex® (bleach)	sodium hypochlorite	water (assumed)	5.25%
Lysol® (kitchen cleaner)	dimethyl benzyl ammonium chlorides	water (assumed)	0.1%
Co-op® orange juice	sugar	water	23 g/250 mL
Mr. Clean®	sodium hydroxide	water (assumed)	0.34%
Pine-Sol®	pine oil	water (assumed)	15%

6. **Textbook questions 1, 2, and 3 of "What Did You Find Out?," p. 45**

    1. The most common solvent depends on the products you examined. In the sample, the most common solvent is water.

    2. Cleaning solutions, weed or garden chemicals, and medicines tend to list concentrations on the label.

    3. With weed or garden chemicals and medicines, government regulations may require manufacturers to list the concentrations. The concentration of solute suggests how strong the solution is.

7. The oil stays on top of the water because it is lighter than water and because it is not soluble in water.

8. The food colouring moved through the oil as a drop.

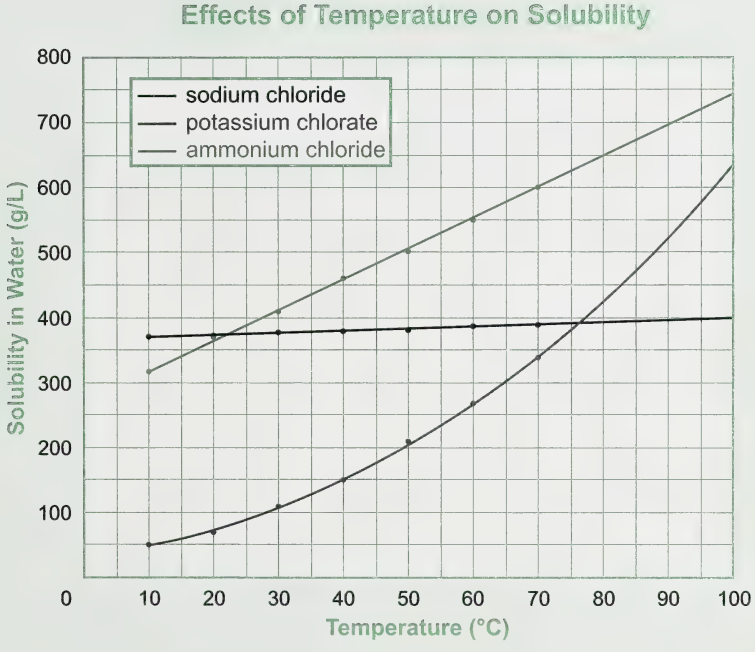
9. The food colouring mixed immediately with the water when it reached the water layer. It almost appeared to "explode" into the water.

10. If you add water on top of the oil, the oil will rise to the top within a few seconds.

11. When a substance is soluble in a solvent, it means the substance will dissolve in that solvent.

12. When a substance is insoluble in a solvent, it means the substance will not dissolve in that solvent.

13. Your graph should be similar to the following.



14. **Textbook questions 1, 2, and 3 of "Analyze," p. 47**

    1. The lines for sodium chloride and ammonium chloride are straight. The line for potassium chlorate is curved.

    2. As the temperature increases, all three graphs rise. The graph of sodium chloride rises slightly; the graph of potassium chlorate is curved; and the graph of ammonium chloride rises much quicker than sodium chloride.

    3. Answer may vary slightly. A sample answer is given.

       The approximate solubility of each solute at 95°C are as follows:

       - sodium chloride: 400 g/L
       - potassium chlorate: 575 g/L
       - ammonium chloride: 720 g/L

15. **Textbook questions 1, 2, and 3 of "Analyze," p. 49**

    1. a. Yes, the salt dissolved in the water.

       b. No, the salt did not dissolve in the vegetable oil.

    2. a. No, the petroleum jelly did not dissolve in the water.

       b. Yes, the petroleum jelly dissolved in the vegetable oil.

    3. No, the petroleum jelly did not dissolve in the water after it was heated. The petroleum jelly had already dissolved in the vegetable oil, so heating was not necessary.

16. In the past, animal fat and ashes from burned wood were used in making soap.

17. There are three steps. First, the washing machine agitates the clothes to loosen the dirt. Secondly, the soap solution dissolves the loosened dirt and the dirt that is still attached to the clothes. Thirdly, further agitation and rinsing wash the dirt away from the clothes.

18. Clothes should wash better in warm water than cold water because increasing the temperature of the solvent (water) should increase the amount of solute (soap) and dirt that will dissolve in the water.

19. Most people do not use hot water to wash their clothes because hot water can damage the fabric, fade the colours, and cause some fabrics to shrink.

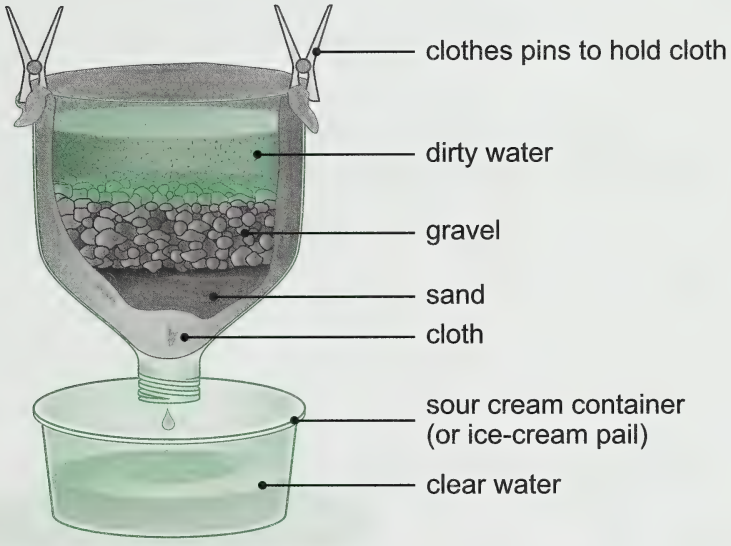
Section 3: Lesson 3

1. The completed lab report should be similar to the following.

Title: Making Dirty Water Clear

Problem: The problem in this investigation is to design and make a filter that will make dirty water clear.

Diagram:



Procedure:

step 1: Design and construct a filter using the apparatus and materials listed.

step 2: Obtain dirty water and pour it through the filter, catching the clear water in a container set below the filter. Time how long it takes for approximately 500 mL of dirty water to pass through the filter.

step 3: Inspect the filtered water and make conclusions.

Observations: The water that came out of the filter was fairly clear. All visible particles were removed.

Conclusion: Using a filter, dirty water can be made clear of sand, gravel, and other debris.

2. **Textbook questions 1, 2, and 3 of "Evaluate," p. 51**

    1. The water that came out of the bottom of the filter was free of debris, but it wasn't necessarily clear. You can see that the visible particles are all removed.

    2. You could make a filter with more surface area using a bleach bottle or some other type of funnel apparatus. You can produce clearer water by having more filter material and finer filter material.

    3. You can prevent the filter from clogging using a pre-filter to remove the larger particles or by allowing the dirty water to settle and only pouring the water and unsettled particles through the filter.

3.

Filter	What It Traps	What Passes Through
furnace filter	dust, pollen (high-quality filters)	clean air (oxygen, nitrogen)
kitchen sieve	pasta, macaroni	water
coffee filter	coffee grounds	coffee solution
tea bag	tea leaves	tea solution
ceramic water filter	bacteria, small particles	purified water
garden sieve	stones	sand and soil

4. a. **Textbook questions 1 and 2 of "Analyze," p. 53**

    1. The salt solution is clear and colourless.

    2. The residue left in the container is white and crusty.

    b. **Textbook questions 3 and 4 of "Conclude and Apply," p. 53**

    3. The water in the solution evaporated into the air as steam.

    4. The substance remaining in the dish (or pot) is salt.

5. The dirt and other particles stick to alum. This makes heavy particles that settle to the bottom of the tank.

6. In step 2, the heavy, dirt-covered alum particles sink to the bottom of the tank; then the clearer water is poured from the top using series of tanks.

   In step 3, the remaining solid particles are removed by filtration.

7. Chlorine is added in the final stage of the purification process to kill any remaining bacteria.

8. Distillation removes bacteria and viruses through evaporation of the water. Only the water particles evaporate. Other larger particles, such as bacteria and viruses, remain behind.

9. **Textbook questions 1.a. and 1.e. of "Check Your Understanding," p. 55**

   1. a. Filter paper can be used to separate solid particles from a liquid. The mixture is poured into a container with the filter paper. The liquid passes through the filter, and the solid particles are caught in the filter.

      e. A window screen can be fitted on the bottom of a box frame and used to separate fine solid particles from larger solid particles. Pour the mixture in the box frame and shake the box frame until all the fine particles have passed through the screen.

Section 3 Review

1. **Textbook question 1 of "Reviewing Key Terms," p. 56**

   1. a. A solute (smaller quantity) is the substance that is dissolved in a solution. A solvent (larger quantity) is the substance the solute dissolves in.

      b. You can see the different types of particles in a mechanical mixture. In a solution, you can only see one type of particle.

      c. Filtration uses the difference in the size of particles to separate substances. Crystallization uses the process of evaporation to separate a solid from a liquid.

2. **Textbook question 4 of "Understanding Key Ideas," p. 56**

   4. Most solutes dissolve better in warm water than in cold water because the particles in warm water are moving faster and are farther apart. This results in more collisions between the particles of the solute and the particles of the solvent and gives more spaces for the particles of the solute to move into.

3. **Textbook questions 6 and 8 of "Developing Skills," p. 56**

    6. Answers will vary. The following diagram is a sample of a drawing of a mechanical mixture. You can see the different materials.

    8. You can heat the mixture to cause the remaining sugar to dissolve.

4. **Textbook questions 10 and 11 of "Problem Solving/Applying," p. 57**

    10. You can remove the dust from the dirty air by wearing a mask that will catch the dust particles.

    11. The concentration of this solution is 10 g/L.

5. **Textbook question 15 of "Critical Thinking," p. 57**

    15. You can separate the pepper from the sugar by dissolving the mixture in water and filtering the pepper out. You can then recover the sugar by evaporating the water.

Section 4: Lesson 1

1.

Solution	Appearance After Tea Is Added (step 2)	Appearance After Sugar Is Added to Cup 2 (step 4)	Appearance After Lemon Is Added to Cup 1 (step 5)
Cup 1	dark brown		yellowish-brown
Cup 2	lighter brown	unchanged	
Cup 3	light brown		

2. The colour of the tea in Cup 2 is lighter than the colour of the tea in Cup 1 because there is less tea (solute) in the tea solution in Cup 2 than in Cup 1.

3. The colour of the tea in Cup 3 is lighter than the colour of the tea in Cup 2 because there is less tea (solute) in the tea solution in Cup 3 than in Cup 2.

4. The lighter colour of the tea solution indicates that the concentration of tea is less.

5. Yes, colour can be used as an approximate indicator of tea concentration.

6. No, there is no change in the colour of the tea in Cup 2 after the sugar was added.

7. Yes, the colour of the tea in Cup 1 became lighter after the lemon was added.

8. The tea in Cup 2 looks to be the most concentrated after the lemon was added to Cup 1.

9. No, you cannot always use colour as an indicator of concentration of a tea solution.

10. **Frozen Concentrate**

$$\text{Mass of package per serving} = \frac{\text{mass of packaging}}{\text{number of servings}}$$

$$= \frac{33.66\ \text{g}}{5.5\ \text{servings}}$$

$$= 6.12\ \text{g/serving}$$

Drinking Boxes

$$\text{Mass of package per serving} = \frac{\text{mass of packaging}}{\text{number of servings}}$$

$$= \frac{78.72\ \text{g}}{6\ \text{servings}}$$

$$= 13.12\ \text{g/serving}$$

11. **Frozen Concentrate**

$$\text{Cost per serving} = \frac{\text{total cost}}{\text{number of servings}}$$

$$= \frac{\$1.20}{5.5\ \text{servings}}$$

$$= \$0.22/\text{serving}$$

$$= 22¢/\text{serving}$$

Drinking Boxes

$$\text{Cost per serving} = \frac{\text{total cost}}{\text{number of servings}}$$

$$= \frac{\$2.58}{6\ \text{servings}}$$

$$= \$0.43/\text{serving}$$

$$= 43¢/\text{serving}$$

12. **Textbook questions 1 to 4 of "Analyze," p. 61**

    1. The frozen concentrate uses less packaging per serving (6.12 g/serving versus 13.12 g/serving).

    2. The drink boxes cost more per serving (43¢/serving versus 22¢/serving).

    3. Answers will vary. Your chart should be similar to the following.

Product	Pros	Cons
concentrate	• better for environment (less packaging) • less costly	• need to mix in additional container • need to wash container used to make juice in • not convenient
drink boxes	• convenient (drink anywhere)	• more packaging means more garbage • more costly

    4. The concentrate will have the least impact on the environment.

13. Concentrated products have more solute per unit volume of solvent.

14. Concentrated products are better for the environment because there is less packaging and, therefore, less garbage produced. Also, since there is less packaging, less energy is required to produce packaging for concentrated products and less energy is required to transport these products.

15. In Canada, each person throws away about 2.2 kg of trash every day.

16. Approximately 30% of the garbage in landfills is product packaging.

17. Concentrated products are made in smaller packages and, therefore, reduce the volume of packaging that goes into landfills.

Section 4: Lesson 2

1. Vinegar is used as a preservative (and for cooking). Vinegar is an acid.

2. The base used in baking is baking soda.

3. Hydrochloric acid is used to etch concrete before painting and as a toilet bowl cleaner. It is also used to remove built-up limestone from hot-water tanks and sinks (called muriatic acid in trades).

4. Sulfuric acid is used in car batteries.

5. Soaps and detergents are used to wash your hands and clean your clothes. Soap is a base.

6. If blue litmus paper turns red the substance is an acid. If red litmus paper turns blue the substance is a base.

7. Acids and bases are both corrosive and they conduct electricity.

8. Acids and bases are opposite in that

    - acids change blue litmus red, whereas bases turn red litmus blue
    - acids have a pH of less than 7, whereas bases have a pH of more than 7
    - acids neutralize bases, whereas bases neutralize acids

    Properties of taste, reaction with metals, and feel may also be considered as opposite.

9. Lichens, cabbage juice, tea, and grape juice are indicators.

10. Litmus is a dye made from lichen that changes colour in the presence of an acid or base. Litmus paper is a strip of filter paper that is soaked in a weak solution of litmus.

11. The hydrangea flower must have a substance in its system that is an indicator. The acidic soil passes a small amount of acid into the flowers, turning the flower pink. The basic soil passes a small amount of base into the flowers, turning the flowers blue.

12. The pH of apples is 3.0. Most fruits are acidic.

13. Lemons are more acidic than tomatoes. Lemons have a pH of 2.0, whereas tomatoes only have a pH of 4.2.

14. The pH of the water in the Great Lakes is 8.5. This means the water in the Great Lakes is basic.

15. Human blood is slightly basic. Its pH is 7.4.

16. Answers will vary. Your completed chart should be similar to the following. The pH is done with universal pH paper with a colour key for each whole number pH from 1–14.

Substance	Prediction	Red Litmus Paper	Blue Litmus Paper	Colour Change	pH According to Scale	Acid, Base, or Neutral?
ammonia	base	turns blue	stays blue	blue	11	base
lemon	acid	stays red	turns red	red	2	acid
vinegar	acid	stays red	turns red	red	2	acid
tap water	acid	stays red	stays blue	yellow-green	7	neutral
orange juice	acid	stays red	turns red	red-orange	3	acid
cola	acid	stays red	turns red	red-orange	3	acid
shampoo	acid	stays red	turns light red	orange-yellow	6	acid

liquid hand soap	base	turns blue	stays blue	green	9	base
baking soda	base	turns blue	stays blue	green	8	base
table salt	neutral	stays red	stays blue	yellow with slight tinge of green	7	neutral
toilet bowl cleaner	base	turns blue	stays blue	blue	11	base
milk	neutral	stays red	stays blue	yellow-green	7	neutral
CLR™	base	stays red	turns blue	bright red	1	acid

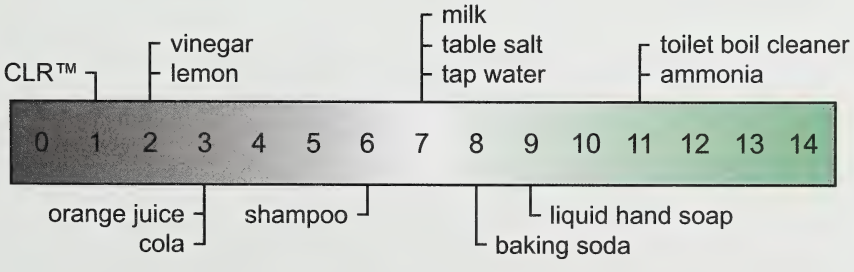
17. a. **Textbook questions 1 to 6 of "Analyze," pp. 67 and 68**

1. You may have completed the Acid, Base, or Neutral column as you did the investigation. See the completed table for answers to this column.

2. Answers will vary. Most of your predictions may have been correct. Those that are close to neutral may have been different.

3. Answers will vary. Items like shampoo that may be acidic may have surprised you. Shampoo is like a soap so you may think it should be basic. Manufacturers deliberately make it acidic.

4. a. and b. Diagrams may vary. A sample pH scale is given.



5. If you completed Part A, answers will vary. A sample answer is given.

   Beginning with the most acidic, the substances in order of pH are as follows:

   CLR™, lemon, vinegar, orange juice, cola, shampoo, tap water, table salt, milk, baking soda, liquid hand soap, ammonia, toilet bowl cleaner

   If you completed Part B, the order of the substances beginning with the most acidic is as follows:

   HCl, vinegar, cola, distilled water, Rolaids®, ammonia, NaOH

6. a. The ammonia tested had a pH of about 11.

   b. The value should be within one pH value.

b. **Textbook questions 7 to 10 of "Conclude and Apply," p. 68**

7. It is inconclusive to test with one type of litmus paper. For example, both an acid and a neutral substance will leave red litmus paper red.

8. a. Universal pH paper would turn pink or red-orange.

   b. Universal pH paper would turn orange-yellow.

   c. Universal pH paper would turn yellow-green.

9. a. Yellow-green would show that the water in the swimming pool is slightly basic.

   b. Yes, because the pH is close to 7, the water should be safe for swimming.

10. a. Red and blue litmus paper used together will tell you whether a substance is an acid or base. Universal pH paper will tell you how acidic or how basic a substance is.

    b. You could use litmus paper to check if the soil in your garden is acidic or basic. You could use universal pH paper to check the pH of the water in a swimming pool or hot tub. You could also use universal pH paper to check the pH of the water in a fish tank.

18.

Substance	Red Litmus	Blue Litmus	Bromothymol Blue	Phenolphthalein	Conductivity	pH	Acid, Base, or Neutral?
distilled water	red	blue	blue	colourless	no	7	neutral
HCl	red	red	yellow	colourless	yes	1.0	acid
NaOH	blue	blue	blue	pink	yes	13.9	base
vinegar	red	red	yellow	colourless	yes	2.7	acid
ammonia	blue	blue	blue	pink	yes	11.9	base
cola	red	red	yellow	colourless	yes	2.9	acid
Rolaids®	blue	blue	blue	pink	yes	10.3	base

19. The cranberry juice changed from red to purple and then to nearly black. Bubbles of carbon dioxide were also released.

20. The colour change suggests that cranberry juice is an acid. It can be used as an indicator since it is red as an acid and purple when enough base (baking soda) is added to make the mixture basic.

21. Your completed table should be similar to the following. It only needs to include four substances.

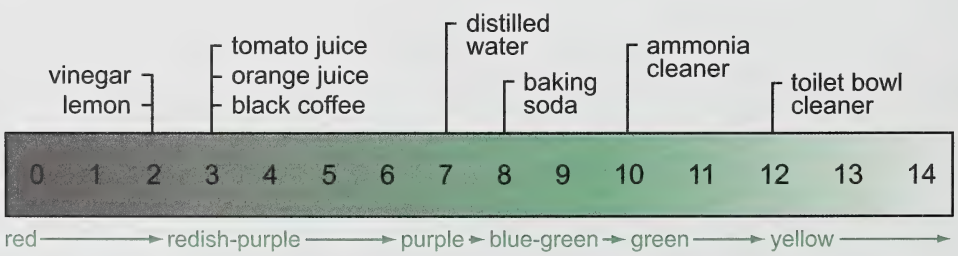
Sample	Colour of Indicator Strip	Colour of Indicator
baking soda	blue-green	blue-green
vinegar	red	red
toilet bowl cleaner	yellow	yellow
black coffee	reddish-purple	reddish-purple
distilled water	purple	purple
orange juice	reddish-purple	reddish-purple
ammonia cleaner	green	green
lemon juice	red	red
tomato juice	reddish-purple	reddish-purple

22. The colour of red cabbage indicator that indicates an acid is red or reddish-purple, depending on the pH of the substance. The colour of red cabbage indicator that indicates a neutral substance is purple. The colour of red cabbage indicator that indicates a base is blue-green, green, or yellow, depending on the pH of the substance.

23. The order of the substances from most acidic to most basic is as follows:

    lemon juice, vinegar, orange juice, tomato juice, black coffee, distilled water, baking soda, ammonia cleaner, toilet bowl cleaner

24. Your colour key should be similar to the following.



25. Yes, the colours for the red cabbage indicator strips are the same as the colours for the liquid red cabbage indicator.

26. Answers will vary. Properties of acids and bases are given.

Properties of Acids

- turns blue litmus red
- has a pH of less than 7
- tastes sour
- conducts electricity
- corrosive
- neutralizes bases
- reacts with metals

Properties of Bases

- turns red litmus blue
- has a pH of more than 7
- tastes bitter
- conducts electricity
- corrosive to skin
- neutralizes acids
- feels slippery

27. Substances that can be used as indicators are as follows.

Indicator	Acid Colour	Base Colour
litmus (lichen)	red	blue
tea	light brown	dark brown
cranberry juice	red	purple-black
cabbage juice	red to reddish-purple	blue-green to yellow
hydrangea flowers	pink	blue
bromothymol blue	yellow	blue
phenolphthalein	colourless	pink

Section 4: Lesson 3

1. The interaction of acids and bases are used in baking (cookies and cakes rising), cooking (changing pH to improve colour and texture of cooked vegetables), health care (using antacid to relieve heartburn), and deodorizing (using baking soda to remove odours inside a refrigerator).

2. The chemical reaction that reduces heartburn when you take an antacid tablet is called **neutralization**.

3. The antacid is a base, since it is used to neutralize stomach acid.

4. A chef may add baking soda to dried beans before cooking them to make a basic mixture that will help soften the beans.

5. It is dangerous to mix certain substances with acids or bases because the chemical reaction may result in the release of deadly fumes.

6. The solution of vinegar and red cabbage indicator was red.

7. The solution bubbled vigorously after the baking soda was added and the solution was swirled. The solution was reddish-purple.

8. The colour of the solution was purple.

9. The blue colour indicates that the solution is now basic.

10. The solution would be considered neutral in step 4, when the colour was purple.

11. The reaction between the vinegar and baking soda is called a neutralization reaction.

12. The primary cause of rusting is the presence of oxygen.

13. Two substances that speed up the process of rusting are acid rain and salt.

14. Acid rain is rainfall with a pH of less than 5.6.

15. Acid rain is formed when pollutants from the burning of fossil fuels react with water in the air to form an acid.

16. Acid rain causes the leaves to appear bleached.

17. Acid rain corrodes metal and stone surfaces.

18. Ships and other objects near bodies of water corrode more quickly than objects in dry areas because moisture speeds up corrosion. Also, if the bodies of water are saltwater, corrosion is sped up by the salt.

19. Lab reports will vary. A sample report is given.

Title: What Corrodes Steel Faster?

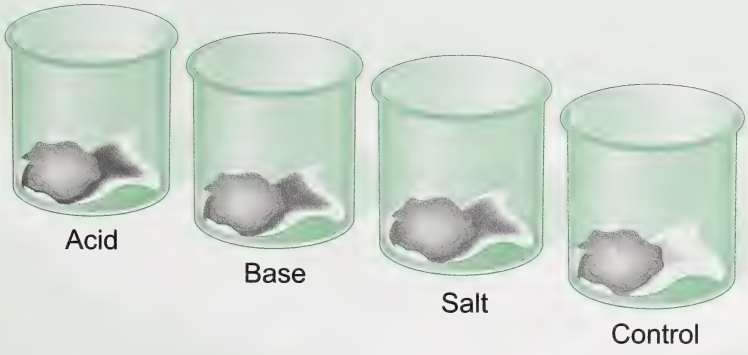
Problem: Analyze the rate of corrosion of steel caused by an acid, a salt, and base to determine which substance causes steel to corrode the fastest.

Safety Precautions: Handle acids and bases with care. Wear appropriate eye and clothing protection. Wash your hands thoroughly after handling the materials each time.

Materials and Apparatus:

- 4 plastic cups (or 400-mL glass beakers)
- paper towel
- steel wool
- table salt
- tap water
- vinegar
- ammonia

Diagram:



Procedure:

step 1: Place part of a paper towel and a small piece of steel wool in each cup.

step 2: Pour enough vinegar into the first cup to soak the paper towel thoroughly. Label the container "Acid."

step 3: Pour enough ammonia into the second cup to soak the paper towel thoroughly. Label the container "Base."

step 4: Dissolve about 10 g (1 level teaspoon) of salt into 20 mL of water. Pour enough of this salt-water solution into the third cup to soak the paper towel thoroughly. Label this container "Salt."

step 5: Leave the fourth cup dry. Label this cup "Control."

step 6: Leave each cup uncovered so the contents are exposed to the air. Record your observations regarding each cup.

step 7: Set the samples aside for 24 h. Then observe the contents again. Record your observations regarding each cup.

Note: Some steps may be combined.

20. **Textbook questions 1 to 4 of "What Did You Discover?," p. 73**

    1. After 24 h, the steel wool in the cups labelled "Acid" and "Salt" had a brown-orange corrosion. The cup labelled "Acid" showed the most corrosion. The cup labelled "Base" showed no sign of corrosion. The steel wool in the control cup also showed no signs of corrosion.

    2. The brown-orange colour and the disintegration of the steel wool was evidence of corrosion.

    3. The steel wool in the "Acid" cup was mush and completely corroded. The steel wool in the "Salt" cup was quite brown. The steel wool in the "Control" and "Base" cups showed no sign of corrosion.

    4. The vinegar caused the steel wool to corrode the fastest.

21.

Metal	Colour of Corrosion
silver	black
copper	green
aluminum	dull grey layer

22. The metal used on roof of the parliament building is copper because it has turned green.

23. Aluminum corrodes until it forms a thin layer of corrosion. This thin layer of corrosion protects the aluminum from further corrosion.

Section 4 Review

1. **Textbook question 2 of "Reviewing Key Terms," p. 74**

   2. Bases turn red litmus paper blue and have no effect on blue litmus paper.

2. **Textbook questions 10, 12, and 14 of "Understanding Key Ideas," pp. 74 and 75**

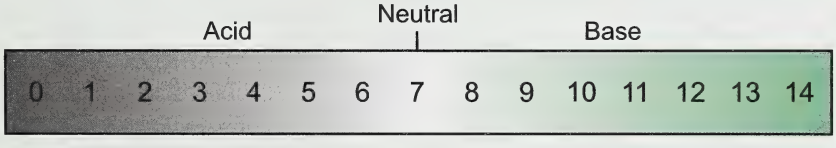
   10. Scientists use indicators to identify acids and bases because the method is safe and reliable. Other methods, such as taste and mixing the acids and bases with other chemicals, may not be safe.

   12. Lemon juice can be added to the surface of the fish to neutralize the fish oil and reduce the smell.

   14. Acids speed up the process of corrosion.

3. **Textbook question 17 of "Developing Skills," p. 75**

   17.



4. **Textbook questions 19 and 22 of "Problem Solving/Applying," p. 75**

   19. The solution was an acid.

   22. a. Rain with a pH of 3.2 would have a greater corrosive effect.

   b. Storing a car in a heated garage will have a greater corrosive effect.

   c. Living on the coast would have a greater corrosive effect.

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Template for Making Dirty Water Clear

Title: _____

Problem: _____

_____

Diagram:

Procedure: _____

_____

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_____

Observations: _____

_____

_____

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_____

Conclusion: _____

_____

_____

_____

_____

Template for What Corrodes Steel Faster

Title: _____

Problem: _____

_____

Safety Precautions: _____

_____

_____

Materials and Apparatus:

- _____
- _____
- _____
- _____
- _____
- _____
- _____

Diagram:

Procedure:

MATERIAL SAFETY DATA SHEET

SECTION 1 — PRODUCT IDENTIFICATION AND USE

ODUCT NTIFIER	Calcium Chloride (Anhydrous) $CaCl_2 \cdot 2H_2O$	PRODUCT IDENTIFICATION NUMBER (PIN)	10043-52-4
ODUCT E			

NUFACTURER'S NAME	Big Chemical Co.	SUPPLIER'S NAME	ABC Chemical Inc.
REET ADDRESS	12345 Somewhere Street	STREET ADDRESS	
Y	PROVINCE	CITY	PROVINCE
STAL CODE	EMERGENCY TELEPHONE NO.	POSTAL CODE	EMERGENCY TELEPHONE NO.

SECTION 2 — HAZARDOUS INGREDIENTS

HAZARDOUS INGREDIENTS	%	CAS NUMBER	LD_{50} OF INGREDIENT (SPECIFY SPECIES AND ROUTE)	LC_{50} OF INGREDIENT (SPECIFY SPECIES)
lcium Chloride	99-100	10043-52-4	oral rat	1000 mg/kg

SECTION 3 — PHYSICAL DATA

SICAL STATE	ODOUR AND APPEARANCE			ODOUR THRESHOLD (ppm)
Solid	White granular			N/AV
OUR PRESSURE Hg) N/AP	VAPOUR DENSITY (AIR=1) N/AP	EVAPORATION RATE N/AP	BOILING POINT (°C) >1600°C	FREEZING POINT (°C) 260°C
Neutral	SPECIFIC GRAVITY 2.15	COEFF. WATER/OIL DIST. N/AV		

SECTION 4 — FIRE AND EXPLOSION DATA

MMABILITY ☐ NO ☒ IF YES, UNDER WHICH CONDITIONS?

ANS OF EXTINCTION

Extingishing media appropriate to surrounding conditions

SHPOINT (°C) AND METHOD	UPPER FLAMMABLE LIMIT (% BY VOLUME)	LOWER FLAMMABLE LIMIT (% BY VOLUME)
N/AP	N/AP	N/AP

OIGNITION TEMPERATURE (°C)	HAZARDOUS COMBUSTION PRODUCTS
N/AV	Chlorides

LOSION A	SENSITIVITY TO IMPACT	SENSITIVITY TO STATIC DISCHARGE
	Not an explosion hazard	Not a fire hazard

SECTION 5 — REACTIVITY DATA

EMICAL STABILITY ☐ NO ☒ IF NO, UNDER WHICH CONDITIONS? Will pick up moisture from the air if left in open container

OMPATIBILITY WITH OTHER SUBSTANCES ☒ NO ☐ IF SO, WHICH ONES? Water, methyl vinyl ether, zinc, bromine trifluoride, mixtures of lime and boric acid, 2-furan percarboxylic acid

CTIVITY, AND UNDER WHAT CONDITIONS Reacts with water to produce considerable amounts of heat

ARDOUS DECOMPOSITION PRODUCTS Emits toxic chlorine fumes when heated to decomposition. May form hydrogen chloride